THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York.

VOL. VII (NEW SERIES) JANUARY, 1920 No. 1

A PLEA FOR THE USE OF THE FLUOROSCOPE IN THE EXAMINATION OF THE HEART AND GREAT VESSELS *

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WITH the return of our medical officers from abroad we are hearing tales of the greater prowess of the roentgenologists of Europe in the use of the fluoroscope, and it seems to me that the present is a fitting occasion to remind you of the many advantages of this method of examination.

It has always been a matter of regret that I found so few roentgenologists practicing in this field in spite of the vast amount of work, and of the refinements of technic which have been developed abroad. To these I offer no new additions, and you will find practically everything that I shall speak of to-day fully discussed by Vaquez and Bordet, by Franz M. Groedel, Dietlen, and others. After having used the fluoroscope for a matter of twelve years, I confess to feeling some irritation at finding the teleroentgenogram and the estimation of the cardiac area by planimeter hailed as a great advance over previous methods. This involves no criticism of the very excellent work published by Bardeen (and adopted by the army), or the value of the data which he has accumulated. The present paper is intended in no sense as detracting from the value of this method. My position is simply this: That although a numerical expression for the ratio of the calculated cardiac area to the normal in the case of a particular individual is a valuable asset in the estimation of cardiac disease, if one confines himself to this determination he is neglecting many possible observations which are exceedingly valuable to the discriminating mind in determining the type of disease present in the heart.

To my mind, it is not enough to determine the actual size of the heart. One should also attempt to estimate the relative size of the various chambers of the heart, and as I shall attempt to show, this is virtually impossible by radiographic methods. In addition, it is further possible by direct observation of the cardiac movements to gain some idea of the vigor of the heart muscle itself, of its relation to the remaining structures of the thorax not only in a static but in a dynamic sense.

By means of these observations we are then in a position to assist the internist in a determination not only of the actual size of the heart as a whole, but of its individual chambers and of the functional capacity of the muscle.

Of course, everyone realizes that the roentgenologist cannot in every case expect

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3-6, 1919.

to diagnose the ordinary valvular lesions with the same degree of accuracy as a skillful internist. The latter may discover two perfectly diagnostic murmurs indicating two distinct lesions in a given case (since a murmur is qualitative evidence and not quantitative), while the roentgenologist sees but one. The roentgenologist, who is obliged to judge by the consecutive changes in the size and volume of the heart or of its various chambers, finds evidences which are in direct ratio to the volume of the regurgitation, i.e., quantitative rather than qualitative. In the presence of a major and a minor lesion, it therefore follows that he finds the evidence only of the major and overlooks the minor lesion. The very fact that he fails to discover the minor lesion is of considerable importance to the internist in his prognosis and in the future conduct of his case. In another instance, the internist may be in doubt as to whether the murmur he hears represents an organic valvular lesion or a relative lesion due to a primary disease of the myocardium. In this case the roentgenologist is frequently able to state with considerable conviction the true pathological sequence. Of course, since the end stages of practically all valvular lesions are determined by the secondary myocardial changes, the distinction in the late stages is relatively much more difficult, and often impossible; but this information becomes of less importance to the internist in the same degree.

Perhaps I can best demonstrate the nature of the information and the character of the deductions which have been found useful by the description of our method of examination. In Fig. 1 is reproduced the radiogram of a case of cardiac disease taken at a distance of 38 inches. This silhouette is roughly comparable to that obtained by the Bardeen method, except in its dimensions, and this focus-plate distance has been selected so that there will be no overriding lines in the subsequent treatment of the record.

You will notice that the cardiac outline is comparatively smooth, although fairly distinct throughout its course. The right border shows the right auricular margin and the right border of the arch of the aorta, the

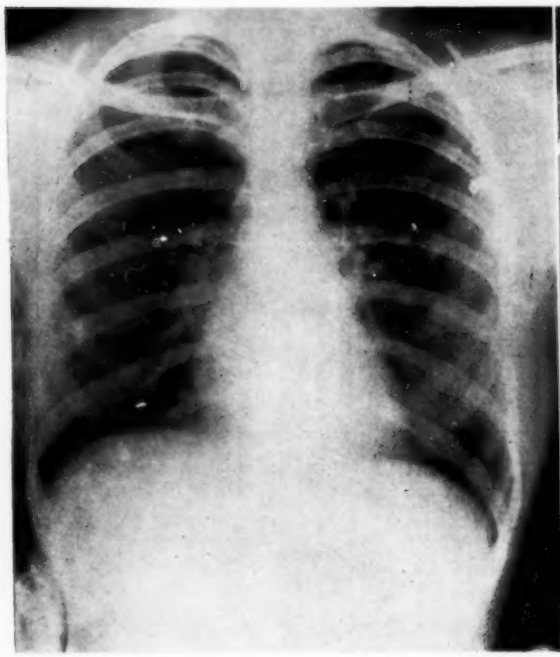

FIG. 1. RADIOGRAM AT 38 INCHES. MITRAL STENOSIS. Note absence of inflections of the border.

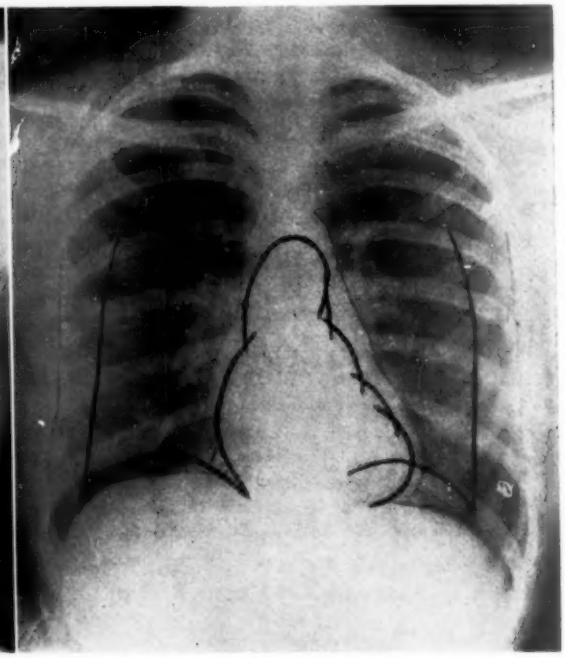

FIG. 2. ORTHODIAGRAM SUPERIMPOSED UPON FIG. 1. Typical "boxing-glove" shape of mitral stenosis.

two normal components of the cardiac silhouette. On the left border the arch and the so-called pulmonary arc are made out with comparative ease. The remainder of the border is made up of the left ventricular border and that portion of the left auricle which normally presents, namely, the auricular appendage. But on the plate we are unable to distinguish the point of division between these two chambers of the heart, and the arc is continuous.

And yet the determination of that particular point is one of the most important data in our determination of the relative size of the chambers.

In Fig. 2 the orthodiagram of this same case has been superimposed in a relatively centered position. You will notice the same outlines on the right side of the heart. On the left side the junctions of the various arcs are represented by rather deep indentations, and the auriculo-ventricular junction is clearly marked. This follows from the fact that in order to determine the course and the direction of intersection of these lines it is necessary to extend these various arcs farther into this cardiac shadow than they are actually seen. Otherwise one would find difficulty in distinguishing between a purely accidental and an intentional departure from a given line of a single dot on the transcription paper. The result of this is that the orthodiagram really is a caricature rather than a faithful likeness of the outline of the heart and to that extent is not entirely truthful. But just as a caricature is intended to bring out the individuality of the person's features, so this caricature of the heart outline makes the distinctive features of its shape more conspicuous and the conclusion more obvious.

The determination of the position of this point rests on the ability to recognize the point at which the ventricular motion differs from the auricular. At this point there is a sort of "walking-beam action" with the formation of a "node of no motion" which is not entirely stationary but moves up and down along the left border. The point is selected at the lowest point of its travel, representing the phase of heart action when the ventricle is contracted and the auricle at least in part dilated. Whatever the exact anatomical position may be, this gives the most nearly characteristic diagrams.

The next figure (Fig. 3) shows the conventional dimensions introduced with the proper notations. We still report the MR and ML dimensions, mainly to satisfy the internist, since by these he checks his percussion. They have, however, a very subsidiary value, depending as they do upon so many factors that can be but poorly

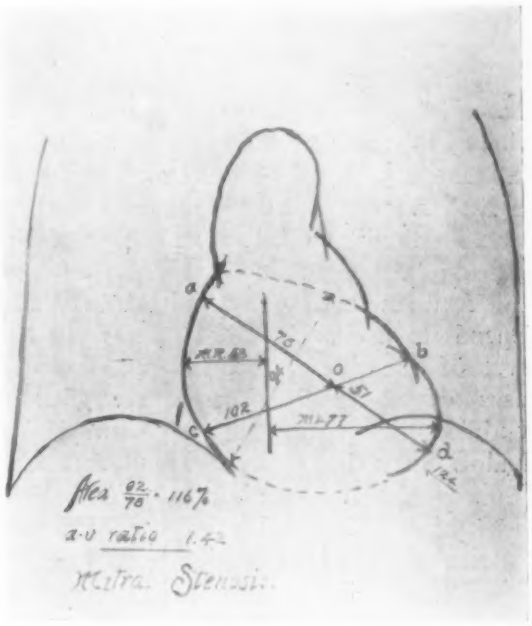

FIG. 3. COMPLETED ORTHODIOGRAM. Actual "area," 92 sq. cm.; average for the patient's weight, 78 sq. cm., a–v ratio, $\frac{ao}{od} = \frac{75}{51} = 1.42$.

evaluated. To a minor degree, the same criticism applies to the ratio of the width of the heart shadow to that of the thorax, recently revived by Shattuck. The oblique diameter also is of doubtful and only indirect value. The long diameter, on the other hand, is of the greatest importance and is the basis of the determination of the area by calculation.

It is only necessary to point out that the so-called oblique diameter extending from the auriculo-diaphragmatic angle to the left

auriculo-ventricular junction roughly corresponds to the dividing line between the auricles and the ventricles. The area above and to the right of this line is therefore a rough index of the auricular area, while that to the left and below represents the size of the two ventricles. In our own work we have attempted to reduce this to a numerical basis by using the ratio of the two segments of the long diameter as intersected by this line (a-v ratio). Normally this ratio is approximately 0.55. With an increase in the auricular area, the value of the a-v ratio rises, the maximum in our experience being 1.42 in a case of mitral stenosis. Per contra, with an increase in the relative size of the ventricles, the denominator of the fraction becomes greater and the value of the ratio diminishes. The minimum in our experience is somewhere in the neighborhood of 0.25 in a case of well compensated aortic regurgitation.

Unfortunately this ratio has many defects. In the first place, the position of the auriculo-diaphragmatic extremity of the oblique diameter is not definitely fixed and depends to a considerable degree upon the level of the diaphragm. So one finds in cases of so-called visceroptosis with a pendulous heart that the right auricular shadow may lie entirely free from the diaphragm, naturally giving a hypothetical or fictitious high value to the auriculo-ventricular ratio. On the other hand, in cases of abdominal obesity and a high position of the diaphragm, this point may lie at a considerable distance above the true auriculo-ventricular junction with a resulting relatively low a-v ratio. In the absence of a definite enlargement, this ratio is almost entirely neglected except as an index to the "posture of the heart."

While the actual numerical expression of these facts is more or less disappointing, we nevertheless find that the basic facts of the position of the left auriculo-ventricular junction and the right auriculo-diaphragmatic junction with respect to the rest of the cardiac area, are of great importance in the estimation of the relative size of the different chambers, and the type of cardiac enlargement.

Further evidence on this point may be obtained by observation of the patient in the right anterior-oblique position, and observing the clear stripe representing the posterior mediastinum. Normally it is of approximately uniform width, and under pathological conditions may be narrowed or obliterated by dilatation (a) of the arch in its upper third, (b) of the left auricle in its middle third, and (c) of the right auricle in its lower third.

Vaquez and Bordet have attempted to estimate the thickness of the ventricles by rotation before the screen until the apex of the heart is tangent to the left border of the vertebral shadow, and by measuring the amount of rotation necessary to produce this. They find that 25 to 35 degrees is normally required. In conditions of left ventricular hypertrophy this angle is considerably increased, even to nearly 90 degrees. In our hands this maneuver has been somewhat disappointing, since the exact angle depends to so great a degree upon the shape of the thorax. One can readily see that in the case of a normal heart in a thorax of round cross-section, the angle would be considerably less than that same heart in a thorax whose cross-section is considerably flattened in the antero-posterior direction. It is possible that the heterogeneity of our population as to race and build may explain our difficulties.

In the estimation of the area of the heart we have been in the habit of continuing the upper border of the left ventricle to join the auriculo-caval junction in a smooth curve and then similarly to close the lower opening of the cardiac shadow. In this way we obviously exclude that portion of the left auricle which projects above the ventricular margin, but we have the advantage of following a line which in many cases is distinctly visible for a considerable distance in the heart shadow. The completion of the lower border is a matter of greater difficulty, both because of the increased distance to be traversed and because of the frequent difficulty in determining the true outlines of the apex. Here I find one must be guided largely by our mental image of the normal

cardiac outline as we habitually see it in the stereoroentgenogram.

The figure so circumscribed is approximately an ellipsoid, and one may calculate its area without danger of great error by applying the formula for the ellipse itself, using as the principal dimensions the long diameter and the greatest dimension which may be erected normal to this line. The product of these values multiplied by $\pi/4$ (.7854) is the approximate area of this figure. We have demonstrated in a series of cases published in the *Archives of Internal Medicine* that the error does not exceed 8 per cent of the planimeter values, and then only in cases of markedly irregular shape and definite hypertrophy, where the error would not cause serious difficulty. To our mind this error is of approximately the same order as the inherent errors of the method, and the accuracy is as great as one needs in so rough an approximation of the area of the heart.

For a number of years we have expressed the size of the heart by the ratio of this area divided by the "norm" for individuals of the same weight. This "norm" was established on approximately seventy-five individuals with apparently sound hearts. When these were plotted in a curve it was discovered that they closely approximated that represented by the following formula: area (sq. cm.)$=3\sqrt[3]{\text{wgt}^2}$ (lbs.). This is simply an expression of the hypothesis that normally the weight of the heart varies directly with the weight of the body and that the comparable areas on similar volumes vary as the cube root of the squares of these volumes. Neither of these hypotheses hold rigidly, but this approximation again is fairly close and is in singularly close harmony with the values deduced by Bardeen except in the matter of the constant, 3. We find that it adds considerably to the internist's appreciation of the size of the heart if we can tell him that it measures 125 per cent of normal rather than, let us say, 103 sq. cm.

It may be objected that our value does not represent the true area of the heart; but if one can determine the relative size of two bodies by measuring aliquot portions and expressing the same in the ratio of these values, it is a matter of complete indifference what fraction of the whole that aliquot portion may be. The only requirement is that the area be compared with a similar area in a normal individual.

In fact, one might as well compare the products of the long diameter by the longest normal diameter without the use of the factor .7854 as in our method, since this factor occurs in both the numerator and the denominator of the fraction expressing the ratio, and therefore "cancels out." The value of the method is not altered in the least, but the logic is less obvious, and one hesitates to choose a name for such a value. We began by attempting to determine the actual area, and conservatism bids us retain the useless factor.

Clinical experience with this "norm" has led us to believe that this value is a trifle too low. We are in the habit of allowing 110 per cent as the upper limit of normal, and a rather greater number of normal hearts reach 110 per cent than fall to 100 per cent or below. It is a rather remarkable fact, however, that all our observations on cases comparatively normal have fallen between these two values, viz., 100% and 110%.

We are in entire agreement with the usual tables in the matter of the influence of stature, build, age and sex. All of these are of relatively secondary importance except at the extremes, and the estimation of their effect is rarely difficult. A factor which is perhaps of greater importance and which has been little emphasized is the pulse rate. Although it is well known that a heart in tachycardia is considerably smaller than the normal, this factor has rarely been taken into consideration. We believe it of such great importance that when we find a rapid heart with an area which is not less than 100 per cent of the norm, we feel confident of a minor degree of dilatation, and, incidentally, the majority of these cases will be found in obvious or latent cases of hyperthyroidism. So firmly convinced is the internist of this that he hesitates to diagnose hyperthyroidism in the absence of such evidence.

It is exceedingly difficult to formulate a description of changes in the movements

of the heart indicative of muscular weakness, and I shall not attempt to do so here. In a general way one gets a sense of incoordination and futility, and this is usually unmistakable. Together with this there is a shapelessness and irregular deviation from our conception of what the shape of the heart ought to be that rarely leaves one in doubt.

In this connection, one must properly appreciate the influence on the cardiac movements of the relation of the heart to the supporting structures of the diaphragm and the anterior chest wall. Ordinarily the heart is supported in the rather deep trough produced by these structures, as the result of which the lower margin and the apex are relatively fixed in position. You are, of course, familiar with the surprise of the beginner at the relatively small excursion of the apex. This follows from the usual conception that during systole the apex, by the shortening of the long diameter of the heart, approaches the base of the ventricle lying near the midline. As a matter of fact, the greater part of the shortening is accomplished by the descent of the base towards the apex. Lateral movement of the lower border is restricted by the diaphragm. The only free margin of the heart, therefore, which is unrestricted in its movement is the left border, and its motion is due to the shortening of the transverse diameter of the heart roughly from the left and above to the right and downward. In this connection it is interesting to note that the apex as determined by palpation usually lies near the outer extremity of this upper margin.

If, however, the heart lacks the support of the diaphragm, but is freely suspended from its attachment in the mediastinum to the deep fascias of the neck, one finds that the base is relatively fixed, while the apex shows a considerably wider range of motion. The lower border is now free to move, and in fact, the entire outline of the heart partakes of the movement, much of it being a movement of the heart as a whole as a response to the recoil from the effort of expulsion of the blood stream into the aorta, somewhat in the nature of a "backlash." It is my personal conviction that the foregoing fact accounts for many of the symptoms of throbbing and palpitation so common in this type of visceroptotics and neurasthenics.

The appreciation of these changes, however, is a matter of experience, and the conviction with which one draws conclusions concerning the cardiac movements is to some degree a matter of temperament.

We have described at some length our own methods and have tried carefully to avoid making it appear that the examination of the heart is a mere question of mathematics. As a matter of fact, it is not. It is a clinical method, and as such requires all a man's skill and judgment. The skill is not difficult to acquire if one can learn to avoid certain difficulties. I have discovered that virtually all my students are guilty at first of approximately the same errors; that the simplest way to correct those errors is by a systematic comparison of the orthodiagram with a good stereographic pair, and that very soon the student becomes independent of such radiographic assistance.

There are no longer any technical difficulties in the application of this method. A very simple modification will allow one to make orthodiagrams on practically any vertical fluoroscope. There is, of course, the highly important and, to many, the disagreeable feature of the preparation of the retina, for no amount of additional illumination will entirely compensate for the improvement in vision that results from twenty minutes in a darkened room or behind ruby goggles. But to our mind the additional information so obtained abundantly repays the effort, and we entertain the suspicion that this factor has much to do with the reported superiority of European methods.

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THE RADIOGRAPHIC FINDINGS IN PERICARDITIS WITH EFFUSION*

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ALTHOUGH the presence of fluid in the pericardium is a comparatively rare finding in the examination of diseases of the chest, the question of its presence or absence often arises, and the radiologist is frequently called upon to express an opinion. The findings upon which to base such an opinion are not clearly defined in the literature, and from the various statements made in a discussion of this subject at the last annual meeting of this society, it would seem that we, as roentgenologists, have no commonly accepted findings in this disease. The studies which are reported in this paper were undertaken with the hope that some of the disputed questions could be answered and the roentgen findings in pericarditis grouped.

As early as 1897, Dr. Francis Williams reported some experimental work on the opacity of the various fluids of the body to *x*-ray. He was unable to differentiate between volumes of pus, ascitic fluid, blood, and water. From his studies he concluded that there is not sufficient difference in the specific gravity of the various fluids and soft tissues of the body to make their differentiation by *x*-ray possible. In his book published in 1903, he discusses the findings in pericardial effusion and states that when the cardiac area is enlarged, we should note carefully whether or not the pulsations of the left border can be clearly followed. If they can, we have to do with an enlarged heart. If not, we should consider pericardial effusion. He further states that the signs in pericardial effusion differ with the amount of fluid present. The larger amount increases the shadow of the cardiac area and obliterates the pulsating outlines of the left border of the heart, and the heart shadow becomes more rounded. In small effusions it should be remembered that the fluid is largely in the most dependent part of the pericardial sac. To detect its presence we must note what change, if any, has taken place in the cardiac outline and whether its outline is modified by change in position of the patient. He recommends the following positions for examination:

"*Sitting position:* Tube behind patient and screen in front of chest; deep inspiration. The lower and posterior border of the heart should be determined as far as possible; if the outline of the triangular area formed by this portion of the heart is not changed, there is probably not much if any pericardial effusion present.

"*Recumbent position:* Deep inspiration. An examination should also be made with the patient lying on his back, and also on his right and left sides, and with the light going through the body horizontally, the tube being on a level with the heart, to determine whether or not in this position there is any modification of the outline of the heart.

"The outline of the heart and the effusion should be drawn during inspiration and expiration."

Dr. Frederick C. Shattuck read a paper on pericarditis before the Association of American Physicians in 1897, in which he called attention to the increased dullness below the clavicle on the left in the front of the chest only, and to changes in the shape of the cardiac dullness with change of position of the patient. He laid considerable stress on the latter finding. He also stated that the impulse may or may not be felt and that the heart is not always forced upward in the front of the chest by the fluid.

In the discussion of this paper, Dr. T. M.

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

Rotch spoke of his recent experimental work. He felt convinced, in spite of the general opinion to the contrary, that the heart sank in pericardial effusion, and for this reason was a greater distance than normal from the chest wall. He also spoke of the change in shape of the heart dullness, particularly an increase to the right in the fifth and sixth interspaces, with increasing effusion. He reported his experiments and called attention to the change in the cardio-hepatic angle, known as Rotch's sign. This sign until recently has been generally accepted by clinicians.

Goodrich B. Rodes reviews 62 cases of suppurative pericarditis and discusses the literature up to 1915. He calls attention to the two sinuses of the pericardium, the greater of which is situated to the right of the great vessels at the base of the heart, and the lesser along the right posterior edge opposite the fifth interspace in front. He states that these sinuses are the first to fill when fluid is present and that they have a capacity of 200 c.c. Because of the posterior position of the lesser sinus, when it is filled the heart is pushed forward. This condition he describes as the first stage and states that it is recognizable only by careful radiographic study. The second stage is reached when the pericardium is completely distended. An increase in the amount of fluid beyond this point raises the pressure within the pericardium, and when it eventually reaches a point greater than the intra-auricular pressure there will be interference with the heart beat. This condition he classifies as the third stage. The radiographic findings are not discussed. He shows plates in which there is extreme enlargement of the heart shadow, especially the base, with obliteration of the normal cardiac outlines. The heart is not visible within the pericardium in the case reported, although a quart of pus was removed from the pericardium at operation. He does not say whether he has ever seen the heart shadow within the pericardium.

The standard textbook on physical diagnosis generally includes in the signs of fluid in the pericardium increased dullness, particularly at the base, faint or absent apex impulse, change of the cardio-hepatic angle, and change in the shape of the dull area with change of position of the patient.

From this brief review of the literature, it would seem that there is a rather general agreement among internists and radiologists that with fluid in the pericardium the cardiac area changes both in size and shape, the shape depending upon the amount of fluid present and upon the position of the patient when being examined. The findings are founded upon an anatomical and physical basis. Opinions differ as to the position of the heart in the pericardial sac and the visibility of its pulsations when there is fluid present. None of the authors whom I was able to consult stated whether or not it was possible to visualize the heart within the fluid-filled pericardium by *x*-ray, or whether its shadow if seen should be negative or positive. Kassabian in discussing the shadow of the heart in pericarditis states that the density is less at the periphery, and that it gradually increases toward the mid-portion. Knox in his book shows an illustration under the heading of "Hypertrophy and Hydropericardium" in which the left border of the heart seems to be visible within the pericardium. He makes no reference to this in the text.

As the roentgen findings in any examination are based on changes in size, shape, density or movement, and on the position of the shadows studied, it is obvious that to add anything to the roentgen diagnosis of pericarditis with fluid not already known and accepted, one must answer the following questions:

1. Is the shadow of the heart visible within the fluid-filled pericardium?

2. What effect does fluid have upon the visibility of the heart beat?

3. What effect has fluid in the pericardial sac upon the shape of the cardiac shadow?

An attempt was made to attack the problems from both the clinical and experimental sides. The records of 60 cases which had been diagnosed more or less positively as pericardial disease were studied

and in addition the following experiments were performed.

Experiment No. 1.—The object of this experiment was the determination of the appearance of the heart shadow when that organ was immersed in fluids of varying specific gravities. The chest of a freshly killed, medium sized dog was opened and the cardiac vessels tied off. These vessels were then severed outside the ties and the pericardium trimmed away. The heart was then removed from the body and suspended by threads inside of a paraffin coated box so that it lacked about an eighth of an inch of touching the bottom. The box was filled successively with substances of six different specific gravities and radiograms made of all six preparations on the same plate under identical conditions. The substances used were air, ether with a specific gravity of 0.727, tap water with a specific gravity of 1.000, salt solution with a specific gravity of 1.012, salt solution with a specific gravity of 1.020, and salt solution with a specific gravity of 1.036. Where fluids were used, enough was put into the box to bring the level just above the uppermost surface of the heart. The following illustration shows the radiograms obtained in this experiment.

Where the heart is suspended in air its outline is, of course, very sharply defined. In ether, the outlines are not so distinct, but they can be easily made out, and it is evident that the animal tissue is less radiant than the surrounding medium. When the box was filled with water, it was just possible to make out the cardiac shadow and its density appeared to be slightly greater than that of the surrounding substance. However, when the water was replaced by the salt solution having a specific gravity of 1.012 and 1.020, respectively, it was impossible to identify the cardiac outlines within the homogeneous shadows cast by the fluids. In the sixth radiogram, where the specific gravity was brought up to 1.036, the heart again became visible, but in this substance its density was less than that of the liquid in which it was suspended.

When a solid body is placed in a liquid, that body sinks if its specific gravity be greater, and floats if it be less than that of the surrounding liquid. When the heart used in this experiment was placed in ether or in water it sank rapidly to the bottom of the container. When it was placed in a vessel containing the salt solution having a specific gravity of 1.036 it floated. In the salt solution having a specific gravity of 1.012 and 1.020, respectively, it tended to float, but after a time sank sluggishly to the bottom of the container.

It may be assumed, then, that the specific gravity of the living heart filled with blood is not far outside the range of 1.012 to 1.020. The specific gravity of fluids removed from the pericardial sac in cases of effusion varies but is usually somewhere within the same range, that is, between 1.012 and 1.020.

The beating heart is a moving object and its outlines are not likely to be so clearly shown in a radiogram as are those of a dead heart suspended and immobilized, as in this experiment. Therefore, it would seem that the radiographic demonstration of the human heart in pericardial effusion should be most difficult.

Experiment No. 2.—It was the object of this experiment to demonstrate the change in cardiac outline resulting from the injection of ascitic fluid having a specific gravity of 1.012 into the pericardial sac of a living dog. The animal was etherized and the chest opened near the mid-line. The wide respiratory excursion of the heart made it seem advisable to kill the animal before proceeding further. The hollow needle was then at once pushed through the pericardium and about 150 c.c. of fresh ascitic fluid forced into the sac by means of a syringe. Plates were made before and after this procedure, with the animal on its back. Unfortunately a weak place in the pericardium allowed a hernia-like pouch to form near the left border of the heart. Fig. 2 shows the results obtained. In spite of the mishap, it is possible to see that after the injection the cardiac outline is more rounded, the cardiohepatic angle is not obliterated, and the heart

cannot be definitely made out within the shadow of the distended pericardium.

Experiment No. 3.—The object of this experiment was the demonstration of the changes in the cardiac shadow following the injection of salt solution into the pericardial sacs of cases coming to autopsy. The costal cartilages were cut through and the sternum freed and lifted without disturbing the pleura. A rubber tube was then sewn into

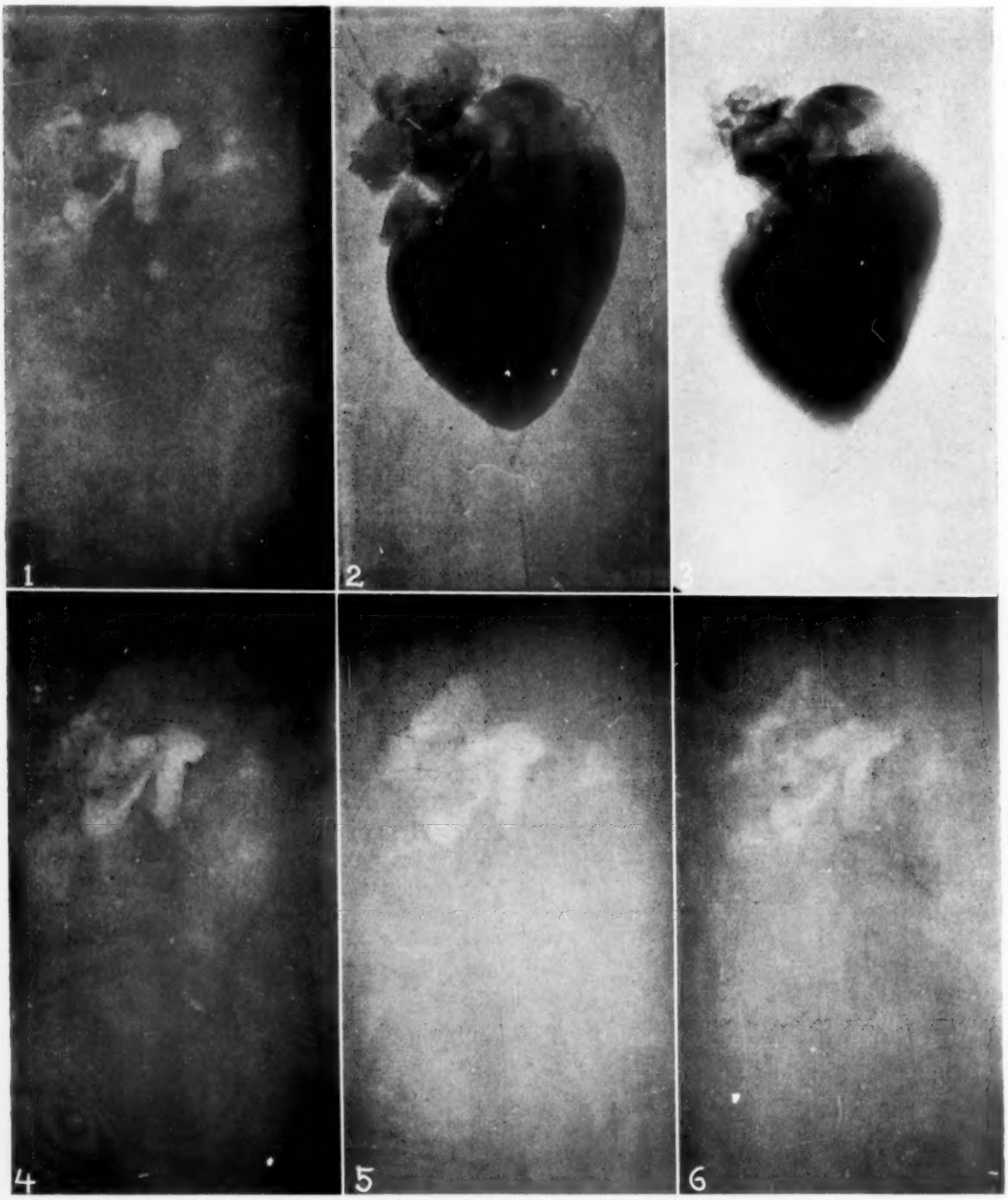

FIG. 1. THIS PLATE SHOWS THE RESULTS OBTAINED IN EXPERIMENT NO. 1, TO DETERMINE THE APPEARANCE OF THE HEART SHADOW IN FLUIDS OF VARYING DENSITY.

the pericardial sac. Salt solution of a specific gravity of 1.012 was forced in with a syringe. The bodies obtained for this work were not very suitable because they had been frozen for some time and the pericardium could be distended only when the fluid was put in under high pressure. As a result, enough fluid was not injected in any of the cases to give the typical picture of pericardial effusion. Fig. 3 shows the heart before and after the injection of about 200 c.c. The curves at the junction of the heart and the great vessels were straightened out, but there was no other apparent change in outline. These plates were made with the subject prone, and it may be that the first change of outline with the patient prone is across the base of the heart in a beginning effusion.

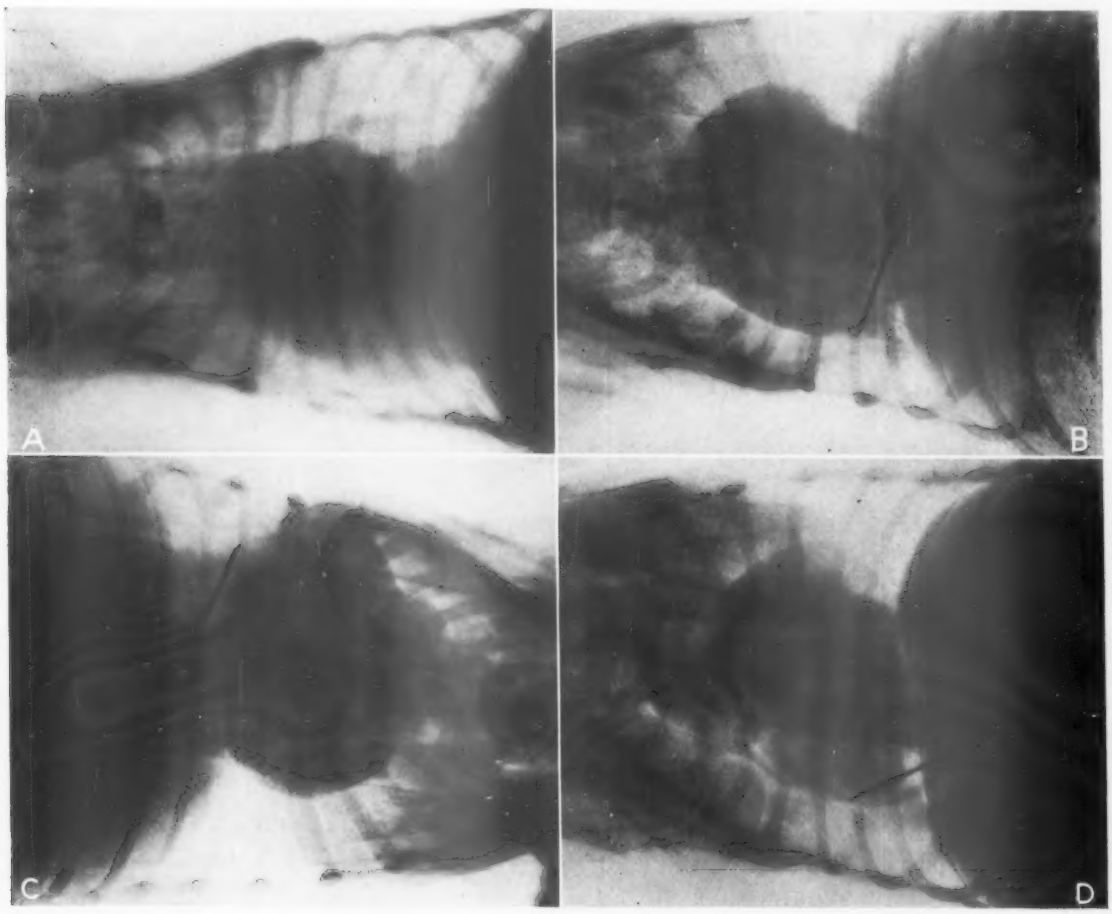

FIG. 2A. THIS PLATE TAKEN WITH THE ANIMAL LYING ON HIS BACK, IMMEDIATELY AFTER ETHERIZATION.

FIG. 2B. THE POSITION OF THE ANIMAL IS THE SAME AS IN FIG. 2A. Plate taken after death, and fixation of the needle in the pericardium. It is to be noted that the shape of the heart is changed somewhat—probably due to dilatation of the auricles.

FIG. 2C. TAKEN IMMEDIATELY AFTER INJECTION OF ASCITIC FLUID INTO THE PERICARDIUM. Note the roundness of the shadow, except for the bulge to the left where there is a hernia of the pericardial sac. Just internal to the point of the needle there is a curved line beyond which there is an increase in density. It is possible that this is the heart apex, although its position and shape are different from that seen in the other radiographs.

FIG. 2D. THIS PLATE WAS TAKEN AFTER REMOVAL OF THE ASCITIC FLUID AND INJECTION OF THE PERICARDIUM WITH AIR. It shows very well the shape of the distended pericardium and the fact that the cardio-hepatic angle is not obliterated by such distending.

In 1917, Morris and Bader published their studies of artificially produced effusions in cadavers. They injected the pericardial sacs

of four bodies four to sixteen hours after death with varying amounts of ascitic fluid (250-1500 c.c.), and made plates of the cardiac region with the tube at a distance of six feet from the thoracic wall. In summarizing their work they stated that the cardio-hepatic angle was never obliterated even after the injection of 1500 c.c., and that the earliest clinical manifestation was an increase in retrosternal dullness which appeared at the same time that the cardiac shadow began to increase in width, and that when the amount of fluid was not too great, it was possible to demonstrate shifting restrosternal dullness with change of position.

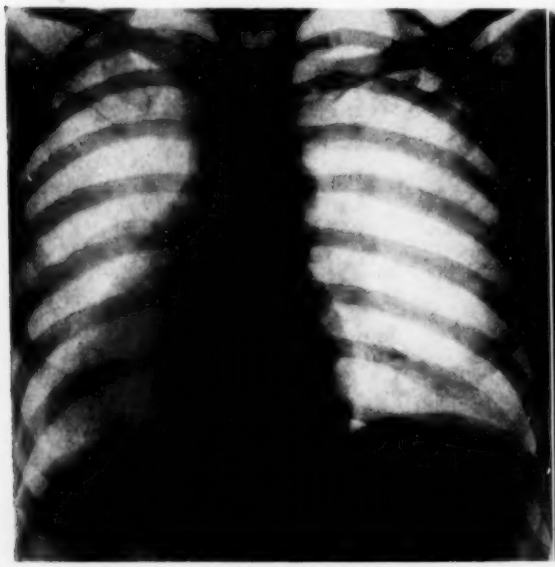

FIG. 3A. THIS PLATE SHOWS THE RESULTS OBTAINED IN EXPERIMENT 3 TAKEN BEFORE INTERFERENCE WITH THE PERICARDIUM.

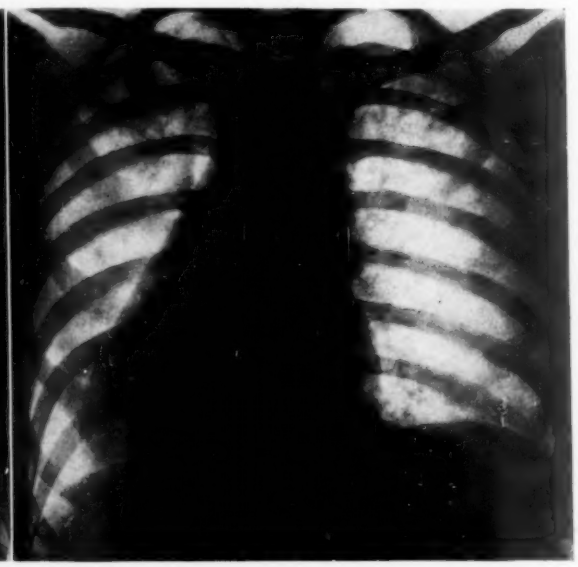

FIG. 3B. AFTER INJECTION OF 200 C.C. OF 1.012 SALT SOLUTION. The most striking feature of this plate is the complete obliteration of the normal curves at the left border of the heart shadow.

CLINICAL STUDIES

Data were obtained from the records of 60 cases diagnosed as probable pericardial disease. In many of them the diagnosis was never definitely confirmed, while in others the condition probably was enlarged heart with adhesive pericarditis. Five, however, had very definite clinical stories and fluid was obtained by tapping. In four the fluid was serous, and in one it was purulent. The specific gravity of the fluid in the first four was not given in the records, but in that containing pus it was given as 1.020. Most of these cases were examined over a considerable period of time, so that although the number of cases is small, there are a fairly large number of examinations. In all of the positive cases the heart shadow was very much enlarged, and there was a definite change in shape with change in position of the patient. In two there was sometimes faint but distinct pulsation present, and in the others no record of visible pulsation was made.

A study of the notes made in these cases gives one the impression that the presence or absence of pulsation in the individual case depends somewhat upon the amount of fluid present. The greater the amount of fluid the less likely are we to see pulsations. In connection with the study of pulsation, I went over the notes on a considerable number of fluoroscopic observations of large hearts which later proved to be due to dilatation. It seemed that absence of pulsation was noted as often in these cases as in the cases proven to have fluid in the pericardium. The cardio-hepatic angle was sometimes acute, sometimes obtuse, and sometimes obliterated. This was equally true

in the cases with dilated heart. Apparently the angle is more likely to be obliterated if the examination is made with the patient in the upright position. The outline of the shadow varies considerably in the different cases. In practically all of them, however, there is an absence of the normal outline of the various chambers, i.e., it is impossible to distinguish the auricle from the ventricle. Also, in practically all the cases, with the patient prone or supine the cardiac dullness rises higher toward the sternal notch and is inner part of the diaphragm is obliterated, or the observation of Destot that the pericardial shadow bulges downward below the diaphragm on the left side and can be seen through the gas bubble in the stomach.

Each case was examined several times, and in many a series of a dozen or more plates were taken. While some of the plates were taken at a distance of seven feet during normal breathing, many were made at the usual chest distance with fairly rapid exposures. I re-examined all of these plates

FIG. 4A. PLATE TAKEN WITH THE PATIENT SUPINE AT THE USUAL DISTANCE USED FOR CHEST WORK. Notice the absence of the normal cardiac outline and the tremendous enlargement of the shadow upward and to the left. The cardio-hepatic angle is flattened but not entirely obliterated. After this plate was taken, 90 c.c. of fluid was removed.

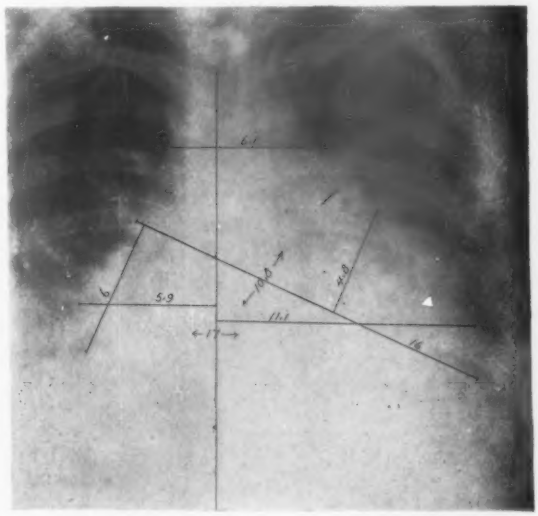

FIG. 4C. TAKEN IN THE SAME POSITION AS 4A ONE MONTH AFTER FIRST EXAMINATION. Clinically there was very little evidence of fluid at this time and a pericardial rub was present. The diagnosis of "adhesive pericarditis" was made In this plate the outline of the cardiac shadow is more irregular and the outline of the various chambers still obliterated.

also increased in width at the base, while when upright, the changes at the base are less marked, and there is a distinct increase in the width of the shadow just above the diaphragm. In several of the cases (including the experimental hearts) there is a distinct bulging of the shadow to the left in the region where the left auricle is usually seen.

I was unable to get much data on the effect of the fluid on the triangle back of the heart, and in no case was I able to see clearly the diaphragm on the left side, so that I am unable to confirm Williams' observation that in pericarditis with fluid the shadow of the in the hope that I should be able to see the outline of the heart shadow within the pericardium, but I was unable to do so. Possibly instantaneous plates would give better results, and where the fluid is of unusual density, with such plates the outline of the heart might be shown.

Pericarditis with effusion must be differentiated from mediastinal pleurisy, cardiac hypertrophy, and dilated heart. Barjon in his book on "Radio Diagnosis of Pleuro-Pulmonary Affections" describes a form of mediastinal pleurisy which he terms "pseudo-pericardial," and shows diagrams illustrating such cases. The mid-chest is

occupied by a large triangular shadow, the apex of which is upward and which from its shape and position resembles very closely the distended pericardium. The shadow of the heart can be seen distinctly through it. The lesion may be anterior or posterior, unilateral or bilateral, and may be combined with diaphragmatic pleurisy or pericardial effusion. But he states it is characteristic of this condition that the abnormal shadow is always superadded to the median shadow,

The point which Destot makes of the absence of pulsation in the margins of the shadow when it is due to fluid outside of the pericardium seems to me a good one. The shadow of the dilated heart resembles very closely that of pericarditis with effusion. Usually the pulsations are so rapid or faint that they are invisible at the fluoroscopic observation. The shape of the heart shadow is rounded and the costophrenic angle may be acute, obtuse or obliterated, but there is

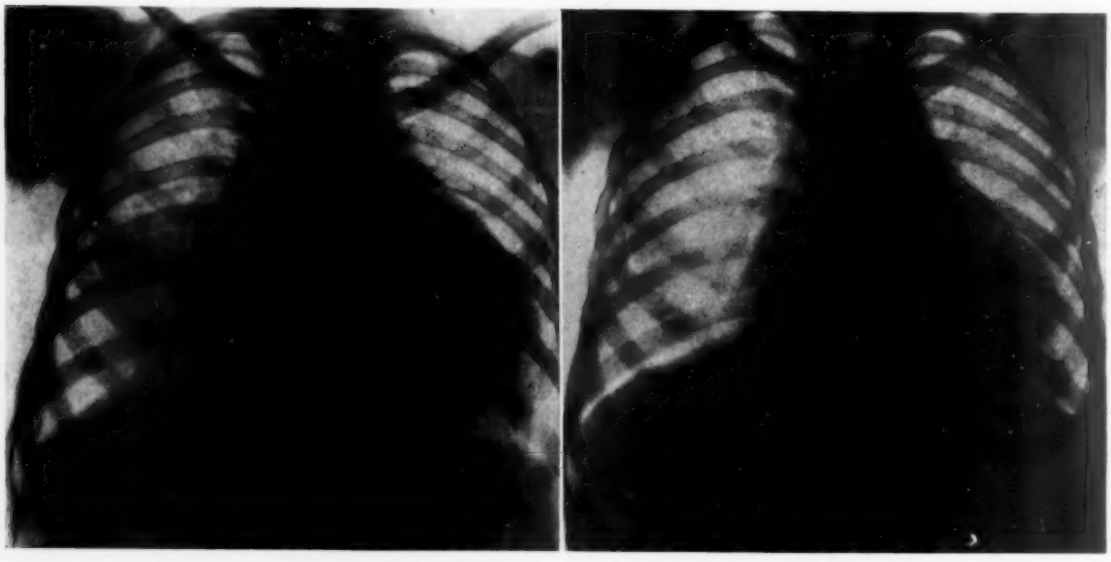

FIG. 5A. SHOWS EXTREME DILATATION OF THE HEART IN A CASE OF PNEUMONIA. Note the obliteration of the cardio-hepatic angle. The outline of the normal heart curves is rather indistinct but not as marked as in the plates of "Pericarditis with Effusion." Careful tracings failed to show any evidence of change of level with change of position, and a dry tap was made. The shadow to the right of the heart is due to consolidation in the lung.

FIG. 5B. SAME PATIENT. Shows marked decrease in the size of the heart under treatment, confirming the diagnosis of "dilatation."

and refers to the work of Devic and Savy who report their studies of mediastinal pleurisy, including a chapter on radioscopic examination by Destot. A point in diagnosis to which Destot calls attention is the disappearance of the heart-beat in mediastinal pleurisy and its presence in pericardial effusion.

If these observations by Barjon are true, mediastinal pleurisy or empyema would account for some of the radiographs in which the heart shadow is distinctly seen within a triangular shadow. Personally, I have never seen such a case.

no change in the shape of the heart shadow with change in position of the patient.

This was very well illustrated in one of our cases in which careful tracings failed to show any change in shape but in which the clinical evidence was so strong that the tap was made. No fluid was obtained. After a short rest in bed the heart was reduced to nearly normal size.

With enlargement of the heart due to hypertrophy, the beat is very strong and the division between the various chambers easily discernible. One is not likely to confuse such a heart with pericarditis with effusion. But when hypertrophy of the heart is complicated by an adhesive pericarditis, the diagnosis becomes more difficult. Dr. William H. Smith, in a study of autopsy

records of 62 cases of adhesive pericarditis at the Massachusetts General Hospital, found no case of an enlarged heart due to adhesive pericarditis alone. The heart shadow in these cases is usually enlarged, its outline indistinct, and the markings of the various chambers may be obliterated. Its pulsations are less well defined than normal and its respiratory movements may be somewhat limited. The diagnosis must be made on the absence of change in shape with change of position.

The method of examination described by Williams is so complete that I can add very little if anything to it. When the patient's condition permits, I think it is advisable to take plates at a distance of seven feet, upright and prone, respectively, as this method is fairly free from distortion and is the most accurate way of obtaining evidence of slight change in shape.

SUMMARY

In pericarditis with effusion, it seems to me that the findings may be grouped in the order of their importance as follows:

1. An abnormally shaped heart shadow which changes with change of position of the patient. (So far as my observations go, this sign is not present in any other condition.)

2. Obliteration of the normal heart outline.

3. Change in shape of the angle formed by the posterior border of the heart, the diaphragm, and the spine.

4. Faint or absent pulsation.

I wish to express my appreciation of the help given by Dr. Charles L. Martin, who did most of the experimental work, and to Drs. Wright and Richardson for the privilege of using their pathological material.

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[The third article of the Heart Symposium, "The Aviator's Heart," by Dr. L. T. LeWald, and the Discussion of the three articles, will appear in the February issue.]

X-RAY STUDIES OF THE SEMINAL VESICLES AND VASA DEFERENTIA AFTER URETHROSCOPIC INJECTION OF THE EJACULATORY DUCTS WITH THORIUM —A NEW DIAGNOSTIC METHOD*†

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THE vast canal system extending upward from the orifices of the ejaculatory ducts in the verumontanum presents a wide field for study hitherto neglected both in Urology and Roentgenology. Only during the past few years has proper attention been paid to the rôle of the seminal vesicles in the production of any one of the numerous types of arthritis, cardiac and gastro-intestinal disturbances and neuroses, and up to the present time the assistance to be derived from the *x*-ray has been practically disregarded.

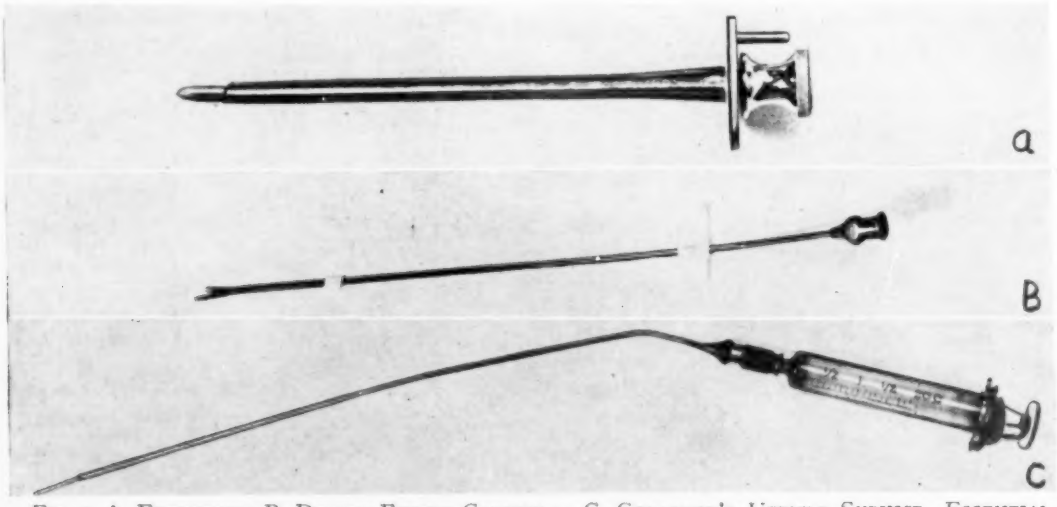

FIG. 1. A. ENDOSCOPE; B. DOUBLE-FORKED CANNULA; C. GERAGHTY'S UTRICLE SYRINGE—ESSENTIAL INSTRUMENTS USED IN THE CATHETERIZATION OF THE EJACULATORY DUCTS. Note the specially devised forked cannula B used in injecting both ducts at the same time. One arm of the fork is 3 mm. longer than the other.

Belfield, Mills, Thomas and Pancoast, and Picker, have published excellent roentgenograms showing the vesicles and vasa injected with opaque substances through a vasotomy.

In the present paper we desire to call attention to a method by which the vesicles can be injected through the catheterized ejaculatory ducts following endoscopy; further, to emphasize the fact that, so far as our experience goes, there is no harmful effect associated with this procedure, and

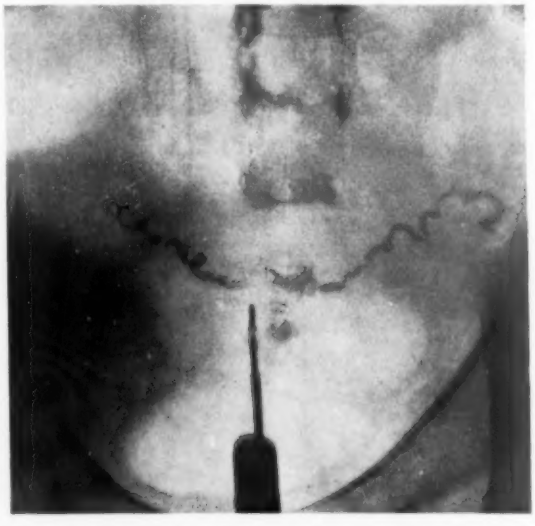

FIG. 2. AFTER THE INJECTION OF THE LEFT SIDE. BOTH VASA DEFERENTIA ARE NOW VISIBLE. The injection can be traced to the approximate location of the internal abdominal ring.

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

†Published simultaneously in the *Johns Hopkins Hospital Bulletin*.

lastly to show that by the injection of thorium it is possible to outline this vast canal system above the orifices of the ejaculatory ducts.

It is generally stated in most textbooks that strictures of the ejaculatory ducts do not occur, and as far as we can find in the literature, Luys is the only one who has attempted to explore the interior of the ducts by "catheterism."

For the past four years one of us (Young) has been endeavoring by means of specially devised probes, filiforms, bougies of metal and whalebone, and with Geraghty's utricle syringe (Fig. 1) to explore and treat the interior of the ejaculatory ducts, the vasa deferentia and seminal vesicles, and in these experiments it has been found that the ejaculatory ducts are easy to locate in most cases even when not visible. A special probe will usually pass upward for a distance of two or four centimeters into the vas deferens. In this way many differences in caliber have been discovered and several cases of marked stricture of the ejaculatory ducts have been made out.

In these cases systematic dilatations, dilated at weekly or bi-weekly intervals, have sometimes brought about almost immediate relief of chronic pain and discomfort in that region. In another paper a description of these cases, the methods employed and the results obtained will be given in detail. In the course of this work we have been struck with the need of a method by which the condition of the canal-system above the verumontanum can be graphically depicted without resorting to opening the vas deferens in the groin as has been done by Belfield, Thomas and Pancoast, Mills and others.

With the introduction of thorium in making roentgenograms, it occurred to us to

FIG. 3. TABLE PRONE WITH TUBE AND COMPRESSION ATTACHMENT IN POSITION.

FIG. 4. SIDE VIEW OF TABLE IN UPRIGHT POSITION.

use this agent for the purpose of getting the much desired pictures of the interior of the vasa deferentia and the seminal vesicles. By using Geraghty's utricle syringe, it has been found easy in most cases to inject one or two cubic centimeters of thorium solution and to obtain excellent radiographs of the vasa differentia out to the external rings (Fig. 2), as will be described later on.

By means of the Young urological *x*-ray table (Figs. 3, 4, 5, 6) it is possible to make stereoscopic *x*-ray plates on the urological table immediately after injecting the ejaculatory ducts as shown in the accompanying illustration.

The utricle syringe is so constructed that the slender tip, which is about 1.5 cm. long, enters the duct for that distance and is then arrested by the shoulder.

This distance is apparently sufficient to carry it always into the vas deferens, as our radiographs have never shown the seminal vesicles when this instrument was used. With a shorter cannula, injections pass into the seminal vesicles.

In the progress of our work, having found it desirable to inject both ejaculatory ducts simultaneously, we devised a special forked cannula, one branch being 3 mm. longer than the other (Fig. 1-B). With this arrangement of the terminal tubes it is easy to introduce the longer tube into one duct for a distance of about 3 mm. and then be free to catheterize the other duct with the shorter tube, after which the instrument is pushed home until arrested by the junction point of the two tubes against the anterior surface of the verumontanum. With this forked cannula we have found it possible to inject 8 c.c. of thorium solution at one time and to inject both seminal vesicles.

We have thus demonstrated that catheterization of the ejaculatory ducts and radiographic study of the canal system

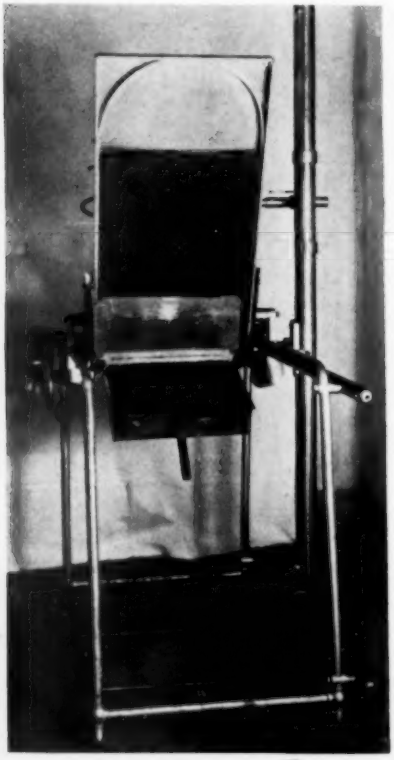

FIG. 5. REAR VIEW OF TABLE IN UPRIGHT POSITION, SHOWING PLATE CARRIAGE IN POSITION FOR EXPOSURE.

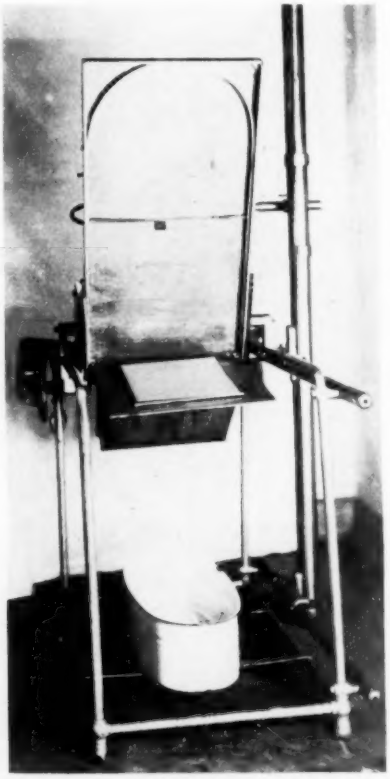

FIG. 6. REAR VIEW OF TABLE IN UPRIGHT POSITION. PLATE CARRIAGE AND HOLDER ARE LOWERED FOR RECEPTION OF THE PLATE.

above may be carried out with ease and furnishes a ready and satisfactory method of determining the condition of these structures. The process is apparently the direct outcome of the combined *x*-ray and urological table (Young's) by means of which it is possible to take radiographs while the patient is in a position for

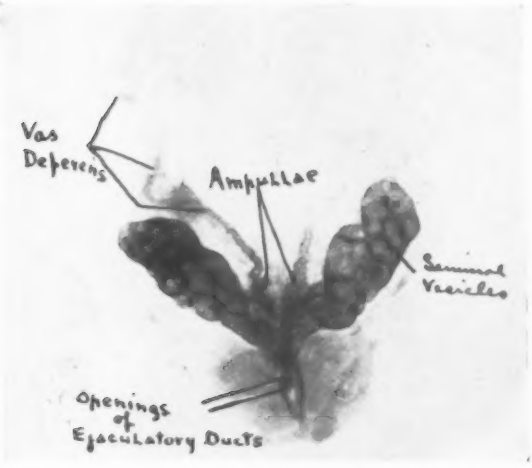

FIG. 7. SHOWING THE ANATOMICAL ARRANGEMENT FROM AN *X*-RAY POINT OF VIEW.

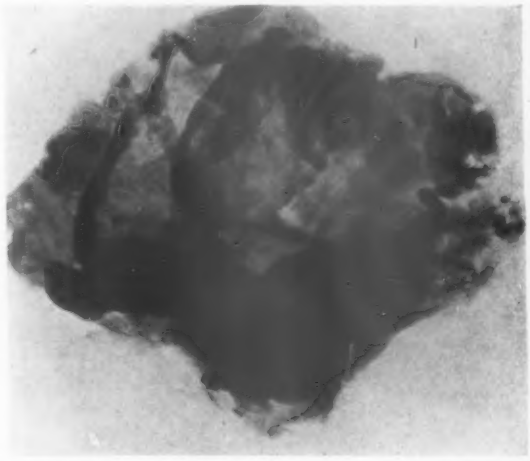

FIG. 8. DISEASED VESICLES AND VAS SHOWING MARKED IRREGULARITY AND DISTORTION.

without danger. In some fifty cases in which the instruments and thorium solution have been introduced for varying distances into the vasa deferentia and seminal vesicles, we have never encountered an epididymitis or any other deleterious sequela.

The development of this method has been

cystoscopy without disturbing him. This table makes it possible to place the patient in the horizontal, vertical, inverted and any intermediate position and to take radio-

FIG. 9. SHOWS THE LEFT SEMINAL VESICLE PARTIALLY FILLED WITH THE CONVOLUTIONS AND SACCULATIONS APPEARING NORMAL.

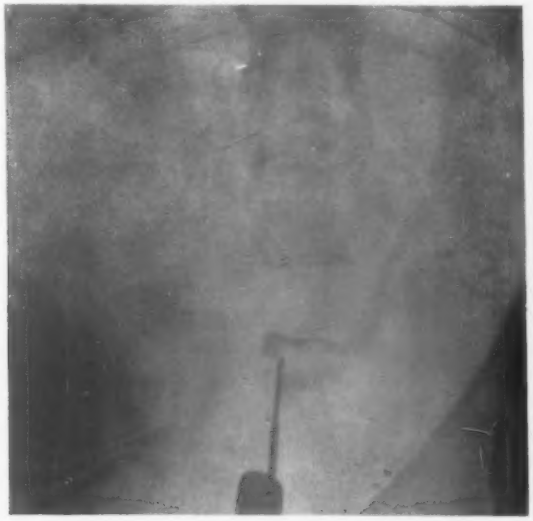

FIG. 10. INJECTION WITH THORIUM SHOWING THE COURSE, SIZE AND CONVOLUTIONS OF THE RIGHT VAS DEFERENS. The vesicles and left vas do not show in this plate. The syringe is seen in the lumen of the right ejaculatory duct. Left not yet injected.

graphs in any of these positions without disturbing the patient or the urologist.

(Note different positions of table in Figs. 3, 4, 5, 6.) The roentgenologist is able to change his plates for stereoscopy under the table with ease and dispatch, as shown in Figs. 5 and 6.

From an *x*-ray viewpoint, the anatomical

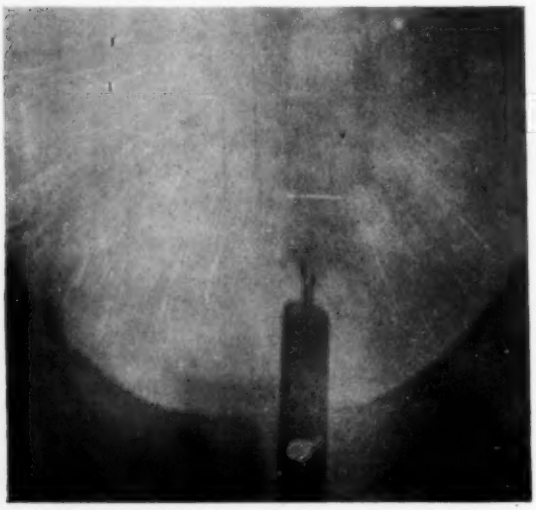

FIG. 11. SHOWS THE FORKED SYRINGE IN THE LUMINA OF THE EJACULATORY DUCTS BEFORE INJECTION WAS MADE.

FIG. 13. DRAWING MADE FROM STEREOSCOPIC PLATES SHOWING BOTH VASA INJECTED.

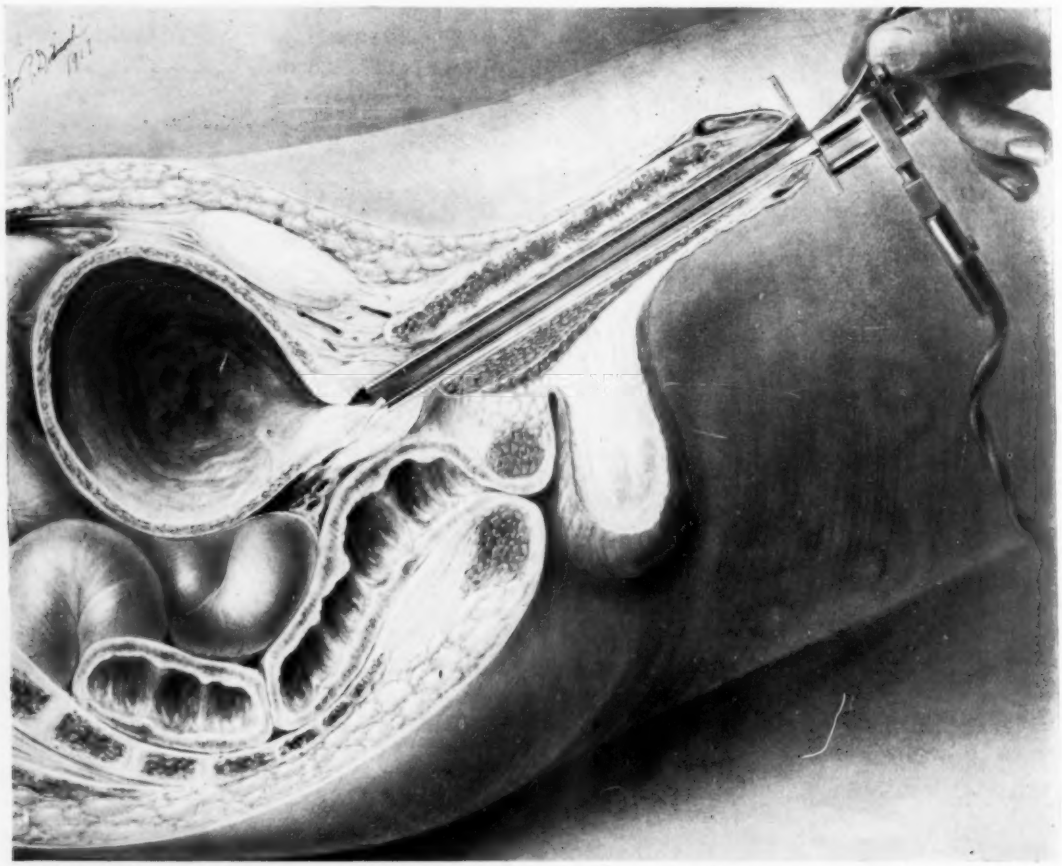

FIG. 12. YOUNG'S METHOD OF DILATING EJACULATORY DUCTS. Probe seen entering ejaculatory duct.

structures of interest in the making of vesiculograms are (1) the verumontanum with the external openings of the ejaculatory ducts; (2) the ejaculatory ducts themselves; (3) the seminal vesicles; (4) the ampullae of the vasa deferentia, and (5) the vasa deferentia above the ampullae (Fig. 7).

The following vesiculograms have been prepared from autopsy specimens with a view of showing the variations existing in the anatomical structures. The specimens have been injected with thorium through the openings of the ejaculatory ducts. The anatomy is clearly shown; the lumina of the ejaculatory ducts are plainly reproduced; while the convolutions and windings of the seminal vesicles and the ampullae of the vas deferentia are clear and distinct. Variations in the vesicles and vasa deferentia have been observed. One typical plate is shown here (Fig. 8). The vesicles are greatly enlarged; their borders are irregular and indistinct, and there is a loss of the normal sacculations and convolutions; both ampullae are markedly enlarged and irregular. The vasa above the ampullae are also seen to be dilated. The whole represents the pathological picture of an obstructive inflammatory process in the vesicles and ejaculatory ducts.

In Figs. 2 and 10 the syringe is inserted straight, first on the left side and then on the right. Only the vasa are seen. In Fig 9, the syringe is inserted at an angle and only the vesicle is seen. The explanation is that in the first instance the syringe passed by the opening of the vesicle and therefore only the vas was injected, whereas in the second instance the syringe entered the vesicle and blocked the vas so that only the vesicle was injected.

Among the conditions for which this method seems applicable and helpful for diagnosis and treatment the following may be mentioned:

1. To determine the patency of the ejaculatory duct or vas in cases of sterility when epididymo-vasotomy is contemplated.

2. To determine whether stricture of the ejaculatory duct, of the vas or of the outlet of the seminal vesicle is present.

3. To disclose the condition of the ampullae of vasa or seminal vesicles in inflammatory or tuberculous conditions.

4. To show the condition of the seminal tract in studies to determine the cause of vague pain in the region of the prostate, vesicles or bladder. Other uses of this method will be forthcoming.

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Discussion

Dr. W. H. Manges.—This is something new and, it seems to me, something extremely important as a field of study. I don't know that any of the specialists have more difficulty in making a differential diagnosis than do the urologists, and their particular field of work in the diagnosis of purulent changes is a most important one. I may illustrate it by saying that a diseased kidney pelvis recognized early is comparatively easily dealt with, whereas if it exists for a considerable period of time, it becomes a menace to life. And so in this work there are no doubt many instances in which a good deal of mental anguish and that sort of thing could be allayed if it were known that some lesion or some anatomical condition or some process in the region of the seminal vesicles were responsible for instance for the lack of procreation. So that I think this is really an interesting and important field for study. Those of you who have worked with urologists, cystoscopists and endoscopists realize what it means to work with an expert. I have worked with both experts and beginners. I am inclined to believe from my former experience that this particular work is one which the expert must do until he has trained assistants to do it for him. In other words, the technique is a most difficult proposition from the urologist's viewpoint.

The history of the progress of our work shows us very clearly that we have as a specialty always come up to meet the necessary requirements. Our technique in the beginning may be a little bit unsatisfactory, but out of the more or less indistinct results we have, as a rule, developed into a point of accuracy, and I can think of nothing more appropriate to illustrate this point than to recall some of the incidents in the life of our late Dr. Leonard. Those of us who knew him well, remember how enthusiastic he was about being able to show the shadows of kidney stones at a time when our exposures were necessarily quite long. Leonard did see kidney stone shadows where no one else could; and so we can in injections of such small cavities as these see the outlines if we know how to study them and find them. It is a difficult technique from our point of view, and, of course, anything in the way of suggestions to improve it are entirely in order. It has occurred to me that here would be an especially opportune time to call in the assistance of the air or oxygen by injecting the bladder perhaps after the little instrument has been placed in the opening of the duct to inject the bladder with air or oxygen. It would remove so much of the soft parts in that region that the shadows of the seminal vesicles and ejaculatory duct would stand out clearly with even a small amount of solution. I am sure when you come to hear Dr. Stewart's paper and see his slides, you will recognize the advantage of displacing surrounding organs by oxygen or air.

I think we are to be congratulated in receiving this presentation and I hope Dr. Waters will continue to develop this line of work in such a way that the rest of us can do it also.

Dr. W. H. Stewart.—I would like to ask Dr. Waters if they have found it necessary to retain the instrument in site after the injection of the thorium. If it can be removed and the thorium still retained in the vesicles, it would be an easy matter to inject air into the bladder. As Doctor Manges stated, a much sharper contrast in the shadows would be obtained.

Certainly the author is to be congratulated upon this advanced work. I believe he will be able, at the next meeting, to give us more information in regard to the patholotical conditions revealed.

Dr. Charles A. Waters.—Dr. Manges' suggestion about injecting the bladder with air prior to the injection of the seminal vesicles is indeed a good idea. We have not tried it but we will as soon as I get home. The injection of the ejaculatory ducts is a comparatively simple procedure once the ducts are located. However, in many instances it requires a tedius and persistent searching to locate their openings. This work is in an elementary stage, but we have shown that it can be done and without harmful effects.

Answering Dr. Stewart's question about holding the cannula in position while the injection is being made, I might say that using the Geraghty's utricle syringe with the tip inserted up to the ampulla of the vas—a distance of 1.5 cm.—we keep the syringe in position. When we do this we should get the vasa deferentia injected because the thorium goes on past the vesicles; while in order to inject the seminal vesicles it is necessary to insert the tip of the syringe a shorter distance. In using the shorter forked arm cannula it is necessary to keep the cannula in position for both injections.

ROENTGEN DIAGNOSIS OF PATENT DUCTUS ARTERIOSUS; WITH REPORT OF A CASE COMPLICATED BY PRESENCE OF SACCULAR ANEURYSM*

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ZINN[1] was the first in 1898 to make an *x*-ray study of the condition in patent ductus arteriosus. He showed that the normal shadow of the heart is modified as follows: The middle area of the left border of the heart shadow is much enlarged, so that in extreme cases a ball-like prominence here surmounts the heart. The position and pulsation phase of this show it to be that of the pulmonary artery. Moreover, whereas the normal pulmonary artery beats but slightly and with less vigor than the aorta, in cases of persistent ductus Botalli the pulmonary artery pulsates more powerfully than its neighbor. On watching this shadow one gets the impression that with each systole the pulmonary artery is actively distended by an increased volume of blood. The observations of Zinn have since been verified by De La Camp,[10] Hochsinger,[11] Bittorf,[12] Groedel[13] and many others.

The enlargement of the pulmonary artery is logically explained by the influx of blood into it from two sources, i.e., the right ventricle and the ductus arteriosus.

Arnheim[2] reported a case in which a diagnosis of patent ductus arteriosus was made based particularly on the *x*-ray showing a much enlarged pulmonary artery. This case, however, on autopsy proved to be a case of extreme pulmonic stenosis. No mention is made in Arnheim's report of fluoroscopic observation of the action of the heart; if this had been done it is probable that the diagnostic error would not have occurred, for it would have been observed that with each systole the pulmonary artery pulsated more actively than it does under normal conditions, manifesting considerable distension as well.

Wessler and Bass[4] state that the symptoms of patent ductus Botalli are:

(a) According to Vierort: systolic murmur over pulmonary area; hypertrophy of right side of heart; accentuated second pulmonary sound.

(b) According to Gibson: long thrill following apical impulse; the peculiar murmur.

(c) According to Hochsinger, who has made a thorough study of the condition: palpable and much accentuated second pulmonic sound; Gerhard's sign, i.e., band of dullness along the left border of the sternum in the three upper interspaces; thrill felt in the jugulum; enlarged pulmonary artery in the *x*-ray plate; murmur in second left intercostal space usually systolic in infancy, but may be diastolic as pulmonary artery develops.

(d) According to Carpenter, the thrill is not always present, the heart is not enlarged to the right and the second pulmonic sound is always essential.

(e) According to Groedel, the persistent ductus Botalli gives the most typical roentgen picture of all congenital heart affections. There is distention and pulsation of the pulmonary artery and enlargement of the right ventricle.

The authors report five cases. In two of these, radiograms were made and showed a distinctly prominent shadow in the region of the pulmonary artery. In each plate the bulging of the pulmonary artery was evident. On fluoroscopic examination the pulsation of this pulmonic shadow was the dominating feature. The heart in each case showed enlargement. Study of the orthodiagrams showed that in patent ductus

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

arteriosus, enlargement of the heart or alterations in its shape may be expected.

The lesion with which patent ductus may be confounded is most usually pulmonary stenosis. According to Hochsinger the diagnosis of patent ductus should not be made in the absence of a much accentuated second pulmonary sound—a second sound if only normal in intensity is more likely to proceed from pulmonary stenosis.

Goodman [3] studied 34 reported cases in which the diagnosis was confirmed by autopsy. Analysis showed him that there was no one particular sign which could be considered as pathognomonic, but that the diagnosis must rest upon the concurrence of a number of signs.

In a case reported by Griffith [5] the radiogram showed that there was a distinct widening of the supracardiac area of opacity referable to the great vessels. This extended further to the right than usual. A well-marked extension of the opaque area passed upward and to the left and presented very distinct pulsation. It was clearly this which caused the systolic elevation of the inner end of the clavicle. Fluoroscopic examination showed the phenomena better than the radiogram.

Hamilton and Abbot [6] reported a case of patent ductus arteriosus with acute infective pulmonary endarteritis. Manges' [9] case was quite similar. In both the usual *x*-ray findings were present.

Miller and Orton [7] reported a case in which the physical sign of patent ductus arteriosus was verified by the radiogram. They refer to the fact that the radiograms in cases of patent ductus arteriosus and aneurismal pulmonary artery may be identical, but that in the latter lesion with a closed ductus no episternal notch pulsation will be detected.

From the foregoing data there seems to be considerable unanimity of opinion as regards the value of fluoroscopic examination in the determination of patent ductus Botalli—namely, that it is important chiefly as confirmatory evidence in the presence of the other characteristic signs. The increased cardiac shadow to the left, the so called *x*-ray cap, caused by the dilated pulmonary artery, furnishes valuable evidence of patency when associated with a systolic murmur in the pulmonic area propagated with greater or less distinctness over the apex of the left lung into the upper portion of the interscapular region.

The occurrence of patent ductus Botalli is more frequent than formerly supposed. In the writer's experience, nine cases have been encountered in which the physical findings and fluoroscopic findings concurred, although only three cases came to autopsy, including the patient cited in this paper, which was referred by Dr. Robert H. Babcock. History is appended.

Mrs. C. was first seen in the summer of 1896 when she was approximately thirty-six years of age. She sought advice on account of attacks of palpitation accompanied by præcordial pain and fear of death. Her family history was unimportant and even in the personal history nothing at first was elicited that seemed of special import. She was the mother of two healthy children and in earlier life had been active in giving public entertainments without any consciousness of cardiac symptoms. It was learned subsequently that her married life was very unhappy and that her attacks were synchronous with, or soon followed her discovery of, certain marital shortcomings. Aside from these hysterical manifestations, as they seemed to be, the patient admitted only some shortness of breath on unwonted exertion. It may be stated in passing, however, that dyspnoea of effort subsequently developed to a very marked degree and coincided with the recognition and growth of the aneurysm as years went on.

Upon physical examination and for several years following the first examination the findings were as follows: The apex beat was inside the left mammilary line and was preceded by a very short slight thrill, while at the left of the sternum in the second interspace was a peculiar pronounced purring thrill which was unintermitting but with a rhythmic diminution and increase of in-

tensity not sychronous with either systole or diastole. Prækordial dullness was only slightly increased transversely, and on auscultation the chief and very striking feature was a continuous diminuendo and crescendo murmur which nearly or quite replaced the two pulmonic tones. The first sound at the apex was roughened and the aortic second tone was moderately accentuated. The urine was negative and blood examination showed a moderate chlorosis. The lungs and abdomen were negative.

As years passed there gradually appeared an area of dullness at the right of the sternum corresponding with the position of the aortic aneurysm, and at length the singular bruit of remitting intensity gave place to a systolic murmur audible also at the right of the sternum and succeeded by a sharply accented second tone. At this time dyspnoea of effort was pronuonced and the

FIG. 1. CASE OF PATENT DUCTUS ARTERIOSUS COMPLICATED WITH SPECIFIC AORTITIS AND ANEURISM, ALSO BY MARKED CARDIAC HYPERTROPHY. Arrow-heads show prominence of the pulmonary artery on which the fluoroscopic examination demonstrated vigorous pulsation.

symptoms were plainly due to pressure by the aneurysm. Finally also gastic crises developed, the nature of which was not recognized,as the existence of lues was never even suspected. There were none of the ordinary stigmata of syphilis and the patient passed through several operations and illnesses without complications and with no more difficulty than would a person free from lues.

Without desiring to excuse the failure to recognize the syphilitic nature of the aortic dilatation, it may yet be stated that in the absence of a specific history and of glandular or other signs of lues, and owing to the fact that Wassermann examinations were seldom made fifteen to twenty years ago, an explanation for the development of aortic dilatation was sought in the possibility of some anomaly which was responsible for the persistence of the ductus arteriosus. It was conjectured that the aorta was narrowed at some point beyond the opening of the duct, and yet there was no appreciable difference in the size of the peripheral vessels in the upper part of the body as contrasted with those of the lower extremities.

Death resulted from sudden rupture of the sac and postmortem examination of the heart and aorta showed the aneurysm to be due without doubt to syphilis.

In this case the original findings corresponded with those described by Gibson and Babcock as characteristic of patency of Botalli's duct, while the symptoms were not those of cardiac incompetence but were neurotic until at length pressure phenomena dominated the scene.

Roentgenologic examination of this case was unfortunately not made until after the aorta had become greatly dilated. It then showed changes due chiefly to the presence and effects of the aneurysm.

There was great cardiac enlargement associated with a corresponding increase in the size of the aorta, which on fluoroscopic examination revealed a saccular aneurysm on the ascending aorta pointing to the right and downward; the pulmonic area was enlarged and showed a marked systolic pulsation.

The anatomic diagnosis made by Dr.

Caylor showed: (1) A spontaneous rupture at the saccular aneurysm of the first part of the aorta. (2) Syphilis of the aorta. (3) Sclerosis of front mitral and left pulmonary leaflets. (4) Slight sclerosis (syphilitic) of the lining of the pulmonary artery. (5) Fatty infiltration of the myocardium. (6) Hypertrophy of the walls of the left ventricle. (7) Dilatation of the left auricle. (8) Fibrous adhesions between the right auricle and base of the aorta. (9) Patent ductus arteriosus. (10) Accessory opening of the right coronary artery.

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X-RAY WORK IN THE CANADIAN EXPEDITIONARY FORCE*

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THE study of the beginning of things is always interesting. The South African War of 1902-4 served to show the possibilities of *x*-ray work, but the high tension transformer had not yet been thought of, and the apparatus with coils and mechanical vibrating interrupters of the "Vril" type, with Neef hammer, and ranging from 6 in. to 9 in. spark gap were the only things available.

The nature of that war, with the greater mortality resulting from disease than from bullets, and of a more or less guerilla character, combined with the comparatively small size of the Expeditionary Force, all militated against the evolution of any very efficient type of *x*-ray unit. Among the lessons learned from that war, however, was the necessity for the reorganization of our medical services, and attention was drawn to the importance of the then new science of radiography. Its possibilities were realized more as an academic than as an actual and serious problem.

The attitude of the medical profession towards radiography at that time must also be taken into consideration. Its value was realized, but it was regarded more as a rather expensive luxury to be utilized as a last resort in difficult and obscure cases than as a routine aid to the surgeon or physician in diagnosis.

Between the end of the South African war and the onset of the Great war in August, 1914, the enormous advantage of radiography as an aid to diagnosis in civil practice had been realized; at its outbreak the necessity of furnishing the various military hospitals with an efficient *x*-ray equipment became urgent.

As far as I have been able to find out there was at that time in the Canadian Army Medical Service no one specially qualified to advise in this matter, nor was there in

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3-6, 1919.

Canada at that time (or is there even now, for that matter,) any firm manufacturing *x*-ray apparatus. Several equipments were bought from American firms, mostly of the coil type, and in view of our present powerful installations it is interesting to look back on the little 1½ horse power petrol engines driving the small 250 watt direct current generator which in turn supplied the 9 in. coil. These were for the stationary hospitals of 260 beds. For the general hospitals of 520 beds a slightly larger equipment of about 3½ horse power supplying a 12 in. coil through a Wehnelt interrupter was provided, and I well remember the surprise and indignation of a high military officer on being told that three 7 in gas tubes were altogether inadequate for the service that might be required.

The developing was supposed to be done in a small developing box of the type where one sticks one's hands through a pair of light-proof sleeves, manipulates the plates by sense of touch and watches the process through a small piece of ruby glass. It is easy to be wise after the event.

Another type of machine furnished consisted of the petrol motor and direct-coupled alternator with a high tension transformer in a separate box, with cumbrous wires leading from the generator to the transformer, back to a rectifying disc made of red fiber, which either warped very rapidly, or shorted and burned!

In view of the comparatively powerful installations available at that time they were puerile. Evidently the nature of the country and density of population over which battles would have to be fought was not reckoned with, and everything seemed to be sacrificed to portability.

Even with such inadequate apparatus, the shortage of shipping was so acute that it was not until December, 1914, that this apparatus reached us in England, although the First Contingent sailed from Canada in September of that year.

We were momentarily expecting to be sent over to France, and so permission was sought and obtained to purchase equipment in England. Here our difficulties commenced, because the high tension transformer, while not unknown, was very scarce in England. Moreover, facilities for the manufacture of high tension rectifying devices did not exist, and so a compromise was effected: when designed, a motor generator set of 15 h. p., direct coupled to a 12 k. w. direct current 200 volt generator used, with a specially wound low ratio 20 in. coil with a mercury-jet interrupter.

The equipment as finally furnished was practically that which I had submitted to the authorities at Valcartier Camp, Canada, shortly before sailing in September, 1914. The size of this equipment was a little staggering to the imperial authorities in France, and the space required was only obtained with greatest difficulty.

The first Canadian hospital to reach France was No. 2 Stationary and this had to be satisfied with the equipment which reached us some time in January from Canada. The second one to go over was No. 1 General, to which I was attached, and this one took over the large installation above mentioned.

With the exception of administration buildings and operating block this hospital was all under canvas. By the time the tents were up a small engine room 10 feet square had been built of frame and corrugated iron to house the generating set. There were, however, no electric lights in the camp, although it was wired, and so for six weeks during the day we used the current for the *x*-ray, and during the night we were using separate feed wires which supplied 250 lights to the hospital.

Looking back at the installations as they existed in the early days of the war, compared with those which now equip our military hospitals in Canada, one wonders not so much that the equipment was then so deficient, as that a small nation such as ours, struggling to equip five contingents, succeeded as well as it did. I would remind you that culpability exists not for making mistakes, but for persisting in making them.

It is interesting to note that the first

Coolidge tubes seen on the fields of France were those supplied with our General Hospital equipments; some idea of the capacity of a suitably wound low ratio 20 in. coil working with a mercury interrupter of proper capacity may be gained by knowing that with a 5 in. spark gap 50 milliamperes of current could be passed through a Coolidge tube. As a rule, however, the low amperage technique was adopted. There rarely were more than 12 milliamperes used, with a 6 in. equivalent gap.

Towards the second year of the onset of the war it was realized that clearing hospitals were capable of doing a certain amount of urgent surgical work and *x*-ray equipments were sent to them.

With the advent of two more General Hospitals, the *x*-ray situation became very complicated, as in the absence of any military *x*-ray department in Canada, these hospitals had out of their funds provided themselves with more modern apparatus. However, the fact remains that in my opinion the finest work done by our Canadian *x*-ray departments in France was that of No. 2 General Hospital provided with the equipment manufactured in England of which I have already spoken.

System and Records.—The system of recording adopted was that of a printed requisition with the necessary information filled in and a space for a brief report to go back with the patient. For statistical purposes a system of special index cards was adopted, each with a small projecting tab. The human body having been divided into 10 arbitrary divisions, each tab was suitably labelled, and on the patient being radiographed and recorded, the necessary particulars were entered upon the card corresponding to the part of the body radiographed. These were further subdivided by alphabetical indices so that in looking up the record of any particular cases much time was saved.

Each *x*-ray department was provided with a 5 by 7 inch ordinary photographic camera and a kit for taking lantern slide plates. It was originally the intention that lantern slides should be taken of all plates suitably identified and used for record purposes in connection with pensions. This was never fully carried out, however, owing to the tremendous rush of work. Still, quite a number of slides were made of important and unusual lesions. Printing paper was also provided and where possible a print of the lesion was sent with the patient, but this I fear was more honored in the breach than in the observance. I am quite sure that should the harbor at Boulogne ever be the scene of archaelogical research in the approaching centuries, the tons of *x*-ray negatives unearthed will be a source of much conjecture! Rarely did a negative sent with a patient get nearer England than that same harbor bottom, and who are we to decide the relative value of souvenirs and *x*-ray negatives to the soldier?

With the admission occasionally into the hospital of 500 or 600 casualties at a time, and the subsequent rush next day to evacuate to the Base in England, it was very often physically impossible to do more than decide which cases should go and which should remain. Very often plates were sent with the patient only to be lost in transit. Towards the end of the second year, *x*-ray negatives began to accumulate in large numbers; and rather than lose so much scientifically valuable material it was decided to ship these plates to the Granville Canadian Special Hospital in England, where a photographic Department existed with facilities for making slides. Unfortunately, very often the negatives arrived indifferently packed, occasionally smashed beyond recognition and frequently with the index cards lost. Even under this difficulty, however, sufficient material has been saved to have made the effort worth while, and in the Army Medical Museum in Ottawa the scattered remnants are being gradually assembled.

Equipment of Base Hospitals in Canada.—With the institution of base hospitals in Canada definite plans of *x*-ray departments were laid down, as well as an adequate equipment list. Here every effort was made to use the most modern installation available,

and a glance at the equipment list will, I think, show the thoroughness with which this has been carried out. The installation is the equal of that of any well-equipped civilian general hospital, and the very large use made of it by the recruiting stations for chest and heart examinations, and by the Pensions Boards, testifies to its usefulness.

Of the general work on the field there is not much that can be said which is not already familiar. Those who came later had the benefit of our mistakes, and the advantage of a large number of highly trained medical radiographers.

It was our routine practice to examine all cases coming into hospital first by the screen and then by plates. The vexed question of localization will not be discussed here. Like the making of books, of the devising of localization systems there seems no end. For plate work, as for screening, the triangular method is the basic one. Where practicable and where the number of foreign bodies was not too great, the double axis method was very useful, while for extremity work and for rough localization the parallax method was *very* useful. For complicated work, however, or for brain surgery, or for spinal work or abdomenal work, the compass of Hirtz is without question the most accurate means, but exceedingly cumberous and time consuming.

With the exception of one of our Hospitals (No. 8 at St. Cloud near Paris) this method was not adopted; but localization by the 10 centimeter shift, using a definite anode plate distance and a prepared scale known as the Milnergraph, was found to be sufficiently accurate for all purposes. The whole question of localization, however, like everything else in *x*-ray work, depends largely upon the personality of the operator; and attention to the thousand and one little details with which all *x*-ray men are familiar made for accuracy, just as the neglect of any of them resulted in inaccuracy.

The time is too early yet to tabulate our results and draw conclusions. It is at this time impossible to give any accurate incidence or percentage of lesions.

Of the use of the *x*-ray for purposes other than that of localization of foreign bodies, or bone lesions, there is not much to say. In England our general hospitals utilized it to a certain extent for the treatment of cicatrices, fibrosis and for an occasional skin lesion. Some experiments were carried out for the treatment of large surface wounds, but not to any very large extent.

Protection.—The question of adequate protection very early came before us. We found that many of the British equipments were very poorly protected. The matter was finally taken up by the London *X*-ray Society and a definite standard of protection, for rubber, glass and thickness of lead, decided upon.

The difficulties in the manufacture of suitable glass in England were almost insurmountable, and dependence had to be placed upon suitable lead rubber, and sheet lead. The number of cases of dermatitis in our own Canadian units were exceedingly small —in fact I only know of one case among radiographers which developed any serious dermatitis and that only in the hands; I never saw a patient burned, and I never saw or heard of a patient who had been burned.

Perhaps quite the most extraordinary thing I came across was the case of a man admitted to No. 1 General Hospital, Étaples, with a fractured right jaw, with no visible external wound except a slight cut on the inner side of the lip; he was brought to be radiographed for this and for pneumonia. Careful physical examination failed to show any reason for the fracture or the pneumonia until the persistence of a large shadow under the right clavicle led to a more careful examination, when a piece of metal 2¾ in. long, roughly ⅝ in. wide and not quite a ¼ in. thick was located. The man died of his pneumonia and a postmortem examination showed a piece of high explosive shell case of the dimensions given situated directly under the right clavicle and finally lodging in the position found. How a piece this size could get down from the small wound and do the damage it did to the jaw without any injury to the vital struc-

tures in its path, and without any surface lesion beyond the wound of entry is a mystery.

GENERAL REMARKS

With the end of the war and the demobilization of the forces the question of the future of our specialty takes on a new and important aspect.

Of less importance perhaps is the comparatively large number of men who have taken up the work seriously and decided to make it more or less their life work; of greater importance is the impetus given to it by the demonstrated indispensability of accurate and skilled *x*-ray work, coupled with the special knowledge which comes only with time. Every medical man in whatsoever capacity, has learned to depend on the *x*-ray findings. He is going to carry that dependence into his civil practice. Is he going to utilize a picture made by a technician and make his own diagnosis, or is he going to send his work to a medical man skilled in *x*-ray work?

I want to warn you that you are at the parting of the ways. Apparatus has reached a stage of development where technique is practically fixed, and dependable results in valuable diagnosis will be regulated by the special knowledge of a qualified medical graduate.

May I point out to you that there is a great difference between adopting business *methods* into our profession and commercializing a technique: that a technician is a valuable adjunct to a medical radiographer, but that he should have no place in establishing so-called laboratories. In fine, our art should be part of a university curriculum, and I am glad to note that Cambridge has set the pace by establishing a special course qualifying for a degree somewhat analogous to the Doctorate of Public Health.

RADIOTHERAPY OF UTERINE FIBROMYOMATA. RESULTS, MODE OF ACTION AND INDICATIONS, BASED ON THE STUDY OF 400 PERSONAL OBSERVATIONS*

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Translated by Isaac Gerber, M.D.

THE present communication is the result and the complement of one which I made at London, in August, 1913, at the Twenty-seventh International Congress of Medicine, before the combined sections of gynecology and radiology. At that time, I presented the statistics of the sixty cases of uterine fibroids that I had treated with *x*-rays in my own private practice from 1908 on, and whose course I had followed much more closely and over a greater period of time than is possible with hospital patients.

To-day the total number of cases of this same condition which I have been able to collect amounts to almost five hundred, but the most recent ones have not yet undergone the test of time. The study which I am presenting now is therefore based entirely upon the first four hundred cases of fibroids that I have had the opportunity of treating, and includes the cases previously reported at London.

This report will cover three aspects of the problem: the facts observed; their interpretation from the point of view of the

*Communication at the First Congress of the Association of Gynecologists and Obstetricians of French tongue, Brussels, Sept. 27, 1919.

mode of action of the roentgen rays, which is still a matter of dispute; and the practical indications which follow.

CONDITIONS AND RESULTS OF THE TREATMENT

Since it is impossible to report four hundred cases in detail, I shall briefly summarize the ages of the patients treated, the size of the uterine tumors, the complicating functional disturbances, the technique and duration of the treatment, its dangers, and its action upon metrorrhagias and on the size of the fibroids.

Age of the Patients Treated.—From the viewpoint of age, the 400 cases observed can be divided as follows:

From	55	to 56	years	9	cases
"	50	" 54	"	89	"
"	45	" 49	"	130	"
"	40	" 44	"	126	"
"	35	" 39	"	31	"
"	30	" 34	"	15	"

The percentages of the total were as follows:

Patients of 50 years and above	24.5%
" " 40 to 49 years	64 %
" " 30 to 39 years	11.5%

Dimensions of the Fibromatous Uterus.—From the point of view of situation, dimensions, and size, the 400 uteri treated may be divided into two groups according to whether they escaped or were accessible to abdominal palpation.

The first group, that of the uterus which vaginal examination showed to be more or less enlarged, deformed and lobulated, but which did not rise above the level of the symphysis pubis, comprises only 62 cases.

The second group, which is much more important both in numbers and in the interest of the observations, comprises the other 338 cases. This group is characterized by the fact that the uterine tumor, accessible to abdominal palpation (either alone or combined with vaginal examination), projects more or less above the level of the symphysis pubis.

The percentages of the two groups are as follows:

Intra-pelvic fibroids	15.5%
Fibroids with abdominal projection	84.5%

In order to estimate the volume of uterine tumors, certain precise measurements are preferable to the loose comparisons ordinarily used. When the tumor is palpable, it is easy to measure with sufficient exactness the distance in centimeters of its upper pole from the pubic symphysis. Also the transverse diameter may be measured, and, in some cases of abnormally prominent abdomen, the anteroposterior dimensions may be measured. It is important in making these measurements that the patient should lie in the dorsal decubitus, on a perfectly horizontal plane. Another necessary precaution is to make certain that the bladder has been emptied before the examination.

In the 338 cases where the tumors were palpable, measurements were made according to these conditions. Before treatment, the superior pole of the uterine tumor rose above the symphysis pubis to the following extent:

from	25	to 30	cm. in	9	patients, or	2.66%	of all cases
"	20	" 24	" "	25	" "	7.39%	"
"	15	" 19	" "	51	" "	15.08%	"
"	10	" 14	" "	111	" "	32.84%	"
"	5	" 9	" "	104	" "	30.76%	"
"	1	" 4	" "	38	" "	11.29%	"

Complicating Functional Disturbances.—In the great majority of the patients, the predominating symptom consisted of metrorrhagia, more or less copious, more or less prolonged, and more or less regular in its appearance. In a few of the cases, the severe loss of blood had required packing several times. Many patients were gravely anemic, and in several instances the hemoglobin value had fallen to as low as 50 per cent.

On the other hand, in a fairly large number, the menses had maintained their usual amount, or were only slightly increased. The other chief reasons for which the cases came to treatment were abnormal size of the uterine tumor, very apparent abdominal distension, rapid growth of the tumor, and compression upon neighboring organs, especially upon the bladder. In several of the latter cases catheterization had been necessary several times.

Technique and Duration of the Treatment.—From the point of view of technique, the method which I have always employed is that of giving weekly treatments, which necessarily implies the use of moderate doses. For many reasons, I prefer this to the method of monthly intensive doses, which has been especially advocated in Germany, and also in my own country by a certain number of radiotherapeutists.

Each weekly treatment consists essentially of two successive exposures, one to the right and the other to the left of the median line of the abdomen, just above the horizontal ramus of the pubis. Occasionally, when the uterus is retroflexed, or when the fibroid occupies the concavity of the sacrum or the cervix of the uterus, a third exposure is directed towards the sacral region. Also if the dimensions of the tumor require it, the surface of the abdomen is divided not only into two, but into three, four or even six areas, and each in turn serves as the portal of entry for the rays. Each exposure is localized on a circular surface, 10 centimeters in diameter, by means of a cylinder of lead glass, which is opaque to the *x*-rays. A small disk of wood is placed between the localizing cylinder and the abdominal wall. This depresses the abdomen, flattens its surface, and by means of gentle compression enables us to lessen the distance which separates the ovaries from the skin. The target of the tube is set, according to the size of tube used, from 18 to 22 centimeters (7.2 to 8.8 inches) above the exposed surface. The tube which I used in almost all of the cases was a Thurneyssen tube, with the osmo-regulator of Villard, and an anticathode of platinum or iridium. It allowed the passage of 1 milliampere of current. At the present time, it is replaced by a Coolidge tube, with a current of the same tension, but with three milliamperes, so that the dose can be given in one-third the time. With this new tube, each exposure lasts a maximum of five minutes, instead of the previous duration of ten or fifteen minutes.

In two particulars only have I modified my earlier technique. For a long time now I have used a sheet of aluminum through which the rays are filtered. At first I used 1 to 2 mm.; later 2 to 3 mm.; at present I employ a filter of 5 mm. I have also increased the penetration of the rays, as measured by aid of the spintermeter, so that it has been raised from an equivalent spark-gap of 15 to 20 cm. (6 to 8 inches).

As for the dosage, measured by the Sabouraud-Noire pastille after the passage of the rays through the filter, it usually did not exceed 3 Holzknecht units at each exposure and for each of the areas treated, and reached a maximum of only 3½ units.

In the cases studied the treatment necessitated

From	4	to	11	treatments	in	38	patients
"	12	"	14	"	"	202	"
"	15	"	20	"	"	109	"
"	21	"	30	"	"	45	"
"	31	"	50	"	"	6	"

Thus in 60 per cent of the cases the treatment did not last more than from two and a half to three months, and did not require more than from 12 to 14 weekly treatments.

Dangers of the Treatment.—The only real danger in radiotherapy is an excess of dose, which provokes cutaneous reactions in the form of acute radiodermatitis or of late trophic lesions. All the other dangers that the treatment is accused of are imaginary. The danger of cutaneous lesions can be avoided by a good technique and a certain amount of experience. Only twice have I produced a late ulceration of the abdominal wall, arising in one case four years, and in the other seven years, after the cessation of treatment. These cases were in the early days of radiotherapy of fibroids, being the first and the third of the cases which I treated, when I did not as yet employ a filter of sufficient thickness. A cure was obtained in the first case only after excision of a small area of skin. The second case healed in three months with simple dressings. Since that time I have not observed any similar accidents.

Therapeutic Results—Among the therapeutic results obtained without pain, and

without any change in the usual mode of living, the two principal were the suppression of the metrorrhagia, and the reduction in size of the uterine tumors.

Action on the Metrorrhagia.—Only four times in my experience did radiotherapy fail to save the patients from surgical intervention. In these cases surgery was justified by the serious losses of blood. It seems to me, however, that to-day, with the better technique at our disposal, such cases would have been more successful under radiotherapy. In all the other cases, in addition to the disappearance of the metrorrhagia, there resulted a suppression of the menstrual function. This suppression, accompanied almost constantly by the appearance of hot flushes characteristic of the menopause, was the signal for stopping the treatments. In several cases, before their disappearance the menses became more abundant. Omitting those cases in which the bloody flow was continuous, or so irregular as not to permit differentiation from the true menstrual hemorrage, the following is a list of the number of times that the menses appeared after starting treatment, until they became suppressed. The menopause arrived

Without any further menstruation						.	in	3 patients
After the appearance of				1	period	.	"	61 "
"	"	"	"	2	periods	.	"	128 "
"	"	"	"	3	"	.	"	89 "
"	"	"	"	4	"	.	"	29 "
"	"	"	"	5	"	.	"	9 "
"	"	"	"	6	"	.	"	8 "
"	"	"	"	7	"	.	"	3 "
"	"	"	"	8	"	.	"	4 "
"	"	"	"	10	"	.	"	1 "

Thus in the majority of the cases the menses were suppressed without having returned more than two or three times after beginning the treatment.

This artificial menopause generally remained permanent. In 48 patients, however, or 12 per cent of the entire number treated, it was merely temporary. After an absence of variable duration, generally several months, rarely as long as one, two or even three and a half years, the menses would reappear. A repetition of the treatments resulted in a new menopause, usually after only a small number of exposures. In 9 of the cases, after several months' interval, there was a second recurrence of menstruation, and in three patients even a third. Finally, however, after repeating the treatments, a permanent menopause was obtained in every instance.

Effect on the Uterine Tumors.—In all the patients treated without exception, the uterine tumor was not merely checked in its development, but it diminished in size. In the 62 cases of intrapelvic fibroids, this diminution in size could not be measured exactly, although often estimated roughly by the observers as being a reduction of a third, a half, or two-thirds of the original size; or even as a return of the uterus to its normal state. On the other hand, in most of the palpable uterine tumors, and at nearly every treatment, I used the previously described measurements, which were applied with the necessary precautions. In 278 cases where the results were exactly recorded, I found after each treatment that the distance of the upper pole of the fibromatous uterus from the symphysis pubis was lowered to the amount of

From	1	to	2	centimeters		in	12	patients	
"	3	"	4	"	"	"	42	"	
"	5	"	6	"	"	"	73	"	
"	7	"	8	"	"	"	62	"	
"	9	"	10	"	"	"	52	"	
"	11	"	12	"	"	"	26	"	
"	13	"	14	"	"	"	10	"	
"	16			"	"	"	1	"	

The reduction in the transverse dimensions was no less striking than that of the vertical dimensions. In the cases where the abdominal tumor made a very apparent abdominal projection, I also noted a material lessening in the anteroposterior diameter of the abdomen.

In this reduction of size, which is so constant, and often so marked and relatively rapid, the most interesting aspect, and the one which should always be emphasized is its evolution.

The reduction in size of the palpable uterine tumors begins with the very first

exposures of the set. It is appreciable most often after the third and sometimes after even the second treatment. From week to week, the superior pole of the tumor progressively approaches the symphysis pubis. In the more favorable cases it drops at the rate of about a centimeter each week.

This early reduction in size, which precedes the cessation of the menses by at least two or three months, is also manifest in other ways. In the cases where symptoms of compression exist, especially of the bladder, these symptoms begin to lessen from the very beginning of the treatments, and are improved gradually from week to week.

The above are the actual facts which have been observed.

MODE OF ACTION OF THE TREATMENT

According to the commonly expressed opinion, the action of the roentgen rays in the treatment of uterine fibroids is directed primarily against the ovaries. They produce essentially a "dry castration," the results of which include the regression of the fibroids, just as formerly they followed the bloody castration recommended by Hegar and Battey. The above opinion, put forth originally in Germany, is quite general in that country, from which it spread elsewhere.

In France, however, where the radiotherapy of uterine fibroids was really born in 1904 with the publication at that date of the observations of Foveau de Courmelles, there is a different opinion. A number of radiotherapeutists, including the above, and also Bordier, Laquerriere, Guilleminot, Jaugeas, Haret, Beaujard, Ledoux-Lebard, d'Halluin, and many others whose names I do not recall, have called attention to the fact that the reduction in size of the fibroids treated by the *x*-rays is often much more rapid and more marked than that which follows the physiological menopause.

They have especially shown that this reduction is seen long before the treatment has brought about any suppression of the menses. Wetterer of Mannheim has made the same observations. All these observers, therefore, admit a direct action of the *x*-rays upon the actual fibroids, in addition to the action of the rays on the ovaries.

In this connection, my own observations certainly confirms theirs. The method of weekly treatments, the careful measurements at each treatment, the abundant statistics which I have brought before you all make up a mass of proof, so abundant and exact, that it seems to me impossible henceforth to doubt the *primary and direct action of radiotherapy upon the fibroids.*

To these incontestable proofs I wish to add another, no less important. In three patients, whose fibroids began to increase in size *several years after the natural menopause,* I have seen radiotherapy produce an important reduction in size of the palpable tumors, and a lowering in height of the superior pole by several centimeters.

Finally it must be remembered that the *x*-ray treatment of uterine fibroids is only one of the chapters in the radiotherapy of neoplasms, although for some reasons perhaps the most important. The destruction and disappearance of the neoplastic cellular elements of which the fibromyomata are formed, constitute the chief result of this type of treatment, and the primary manifestation of its action.

It is not necessary, however, to continue the treatment to the stage where the normal cellular elements of the primitive ovarian follicles are destroyed in their turn by the action of the roentgen rays. This is what we can learn by the method of practical measurements.

After the cessation of the menses and the appearance of the hot flushes, characteristic of the menopause, if the treatments are suspended, the uterine tumor will most generally continue to descrease in size, but much more slowly than during the course of the treatment.

However if, after an absence of some duration, the menses should reappear, this return is very often accompanied by an exacerbation in the activity of the fibroid. It begins to grow again, and enlarges appreciably. From numerous observations, I have found that this increase in size pre-

cedes the return of the menses, but is itself preceded by the premature disappearance of the hot flushes. The ovary, which is a gland of internal secretion and the trophic center of the entire genital apparatus, thus manifests a stimulating action upon the development of neoplasms in the muscular wall of the uterus. This is a fact which we must seriously consider. I therefore always impress upon my patients, especially on the younger women, after the artificial menopause has been produced, not to wait until the menses return before taking up further treatments, but to come back for examination if at any time the hot flushes should prematurely disappear. In such cases, the finding of an increase in size of the uterine tumor is an indication for immediate renewal of the treatment.

INDICATIONS FOR THE TREATMENT

In the treatment of fibroids, according to whether radiotherapy is considered as a method of ovarian sterilization, or as a destructive agent acting on the neoplastic elements, its field of application would appear to be more or less strictly limited.

In the eyes of the partisans of the first opinion, the chief and almost exclusive indication for radiotherapy is the metrorrhagia caused by fibroids of small size in women over 40 years of age.

In all the other cases they would prefer removal. Only when surgery is contra-indicated for some reason, such as age, obesity, general poor condition, extreme anemia, pathology in the heart, aorta, lungs, kidneys, or liver, old or recent phlebitis, etc., do they permit radiotherapy, and in these cases merely as an uncertain experiment, and merely as a makeshift.

As a matter of fact in every case in the group which I am presenting, where surgical intervention was contra-indicated for some one of the above reasons, radiotherapy succeeded in producing a complete cure.

According to the results obtained, the scope of the indications for radiotherapy in the treatment of uterine fibroids should be greatly enlarged.

I trust that I have shown that radiotherapy has a direct action upon fibroids, arresting their development and producing a more or less complete regression; that it is as useful before 40 years of age as after; that it is just as efficacious on fibroids of great size as on those of small dimensions; also that it is useful in cases with normal menses as well as in those with metrorrhagia.

I might add that the apparatus and the technique for this mode of treatment are far from having reached their highest degree of perfection. They are continually undergoing transformation and progress. I do not overlook the fact that some observers have announced therapeutic successes obtained much more rapidly than those of the group which I have presented; in some cases in an extraordinarily shorter period of time. May we not hope that in the near future all radiotherapeutists will be able to obtain similar results.

In conclusion, I feel warranted in making the following generalization:

Outside of certain pathological conditions which demand immediate surgical intervention, radiotherapy is applicable to all uterine fibroids.

It has been only with the help of gynecologists such as Bar, Champetier de Ribes, Dalché, Labadie-Legrave, Lepage, Pinard, Ribemont-Dessaignes, Siredey and Tissier, and to surgeons such as J. L. Faure, Gosset, Perier, Ricard, Rochard, Roux (of Lausanne), and Walther, in addition to many other excellent colleagues, that I have been able to collect these statistics, and I express my thanks to all of them. Among them no one has shown me more confidence than Professor Pinard; no one has had more opportunity to verify the therapeutic results obtained; and I wish to express my particular thanks to him.

RADIATION IN INOPERABLE CASES OF CARCINOMA IN THE FEMALE GENITO-URINARY ORGANS*

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ONE year ago we presented a summary of results in 100 cases of inoperable cancer of the cervix and female genital organs treated in the Gynecological Department of the University Hospital, and arrived at the following conclusions:

"1. As a palliative remedy, radium is the treatment par excellence in inoperable cases of cancer of the cervix.

"2. In border-line cases, in which formerly we accepted the grave risks of an operation in the hope of eradicating the disease, we now employ radium; but in the certainly operable class we still advocate a radical operation followed by post-operative radiation.

"3. In cancer of the fundus, even when far advanced, we perform a hysterectomy, resorting to radiotherapy only in the face of grave operative contra-indications."

Our fourth conclusion, which in view of our further experience, we now feel may be modified by a limited claim for actual curability, was as follows:

"4. As yet we claim no cures, but, based upon the observation of a considerable number of inoperable cases which have remained locally healed from one to three years, we venture the hope that the quinquennial test will find several survivors."

Our list now comprises 209 cases since 1913 with the following results:

	Dead	*Not traced*	*Living*
1914	8	0	1
1915	19	1	4
1916	46	8	11
1917	33	3	23
1918	5	13	34
Total	111	25	73

We regret that we are unable at this stage of our report to give a more complete summary owing to the fact that the number of patients not traced is accounted for by two conditions incident to war; first, the decreased number of our hospital staff, rendering it impossible to keep our follow-up system up to date,—and second, the nomadic tendency of an urban population, due to the recent fluctation of our industrial system and the disturbance incident to the housing situation. In endeavoring to trace our patients we have not infrequently found a change of three or more addresses within a few months after their discharge from the hospital. Notwithstanding such omissions in our reports, the showing in this series is rather remarkable, and we have been greatly encouraged to find so large a number of patients, all of whom fell within the inoperable class, still living and apparently well many months subsequent to their last treatment. A number of these cures have been startling; we believe we are justified in our hopes for some permanent cures, and we know beyond cavil that the palliative results have been far and away better than those following any therapeutic measures hitherto employed. In reviewing our results from radium therapy, we find that same bizarre tendency as noted in our previous surgical experience with cancer. From the appearance or even the extent of the disease no one can forecast with assurance the probable outcome of treatment.

When surgical measures are invoked, one frequently ends an operation with a great degree of optimism as to a cure, because the disease has apparently been well circumscribed and has shown no demonstrable metastasis, and yet within a few months it has again appeared with renewed violence at the local site of operation, while in another case, when the frontier zone of the growth has not been satisfactorily encom-

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

passed and the prognosis is bad, the patient may remain free a long time from recurrence or may even be cured. This same peculiarity has been noted in our radium experience. Thus in our 9 cases treated in 1914, the one living patient discredited every forecast and survives to-day, and is to all appearances cured despite a very extensive and a very vicious type of cancer.

A young woman under thirty years of age was taken into one of our hospitals in an almost moribund state from a massive intraperitoneal hemorrhage, incident to a large perforation of the fundus of the uterus from a decidnoma malignum. The surgeon was compelled because of the critical state of the patient to perform a rapid supravaginal hysterectomy. Her convalescence was slow; she left the hospital in a very precarious condition and was readmitted six weeks later almost ensanguinated from a massive vaginal hemorrhage. On examination, a large fixed mass was found in the left side of the pelvis, and a deep irregular crater occupied the site of the cervix. A hasty cauterization was done to save her life. Notwithstanding the hopeless outlook, two applications of 100 milligrams of radium were made at a six weeks' interval. After the first radiation the bleeding ceased and her recovery was nothing less than astounding. This patient's five-year period has been reached, and she is now well and actively engaged in her household duties and has adopted a child. Were we to let this case occupy the center of the limelight and ignore the cases within the shadow a very brilliant argument could be constructed in favor of radium; but surgery has just as remarkable instances of unexpected cures, and we must, therefore, turn to a summary of all cases in order to find a judicial equilibrium. In these startling cases, however, we feel that there may be further guides towards still better results. Possibly through the use of radium or its emanations carried into the depth of a growth a further advance may be made. At least these remarkable cases furnish a further sustaining argument in favor of the cure of cancer so long as the process is still localized and without metastasis when it is attacked either by surgical means or radium.

Other cases in our series are equally noteworthy. It is not our purpose, however, to lay great stress upon these highly gratifying isolated instances, but to base our discussion upon the influence of radium in those patients who are not healed. Time will soon establish the question of final cures. In the meantime we feel that a very important advance has been made in the palliative treatment of even the hopeless cases. Thus, in our cases hemorrhage has almost invariably been stopped for a considerable period, in some never returning, in others recurring at variable periods before the death of the patient. In still others it has been notably lessened, and but seldom has it not been influenced. No argument is required to confirm this beneficent palliation in the case of fear-stricken women, for to those who witness it the results are self-evident. The malodorous discharges are likewise eliminated in a considerable proportion of cases. As to its alleviatory influence on pain we cannot claim so much, and yet it frequently acts most happiiy in this direction. In radium cases, as in surgery, however, we must meet lay criticism as well as professional pessimism where pain is not relieved after radiation, or comes on later in the course of the inoperable case. Frequently this acute terminal agony is charged up to the account of radiation by relatives or friends of the patient, and occasionally the objection to the use of this novel remedy is sustained by the family physician. Every surgeon knows that surgery is likewise condemned under the same conditions. In all propaganda work, therefore, among laymen as well as within our professional circle, the fact should be emphasized that while cancer in its earlier stages is always painless, in its terminal stages it is nearly always agonizing. In this way only may false assumptions concerning any remedy which fails be overcome. In the occasional case in our series in which the pain has been especially severe, we have felt

that possibly there might be a shadow of suspicion in support of this hypothesis; and yet within a few days another case may be seen with identical symptoms in which no treatment whatever has been applied. Even admitting such possibility in the occasional case, the many others which have found relief from pain easily overbalance these objections.

Finally, are there any untoward sequellae chargeable to the radium account? Two are possible. First, does radiation produce pain shortly after the first or second sitting? Occasionally it does. In anticipation of this possibility, we warn the patient not to be alarmed should it occur, for in a small percentage of cases, notwithstanding every care exercised in the protection of the rectum, a very acute proctitis may follow. In such cases, a decided stranguary may be noted at variable intervals, from a few days to three or more weeks, after radiation. Mucous and even blood may be discharged and the pain may be so severe as even to require hypnotics. In some cases opium suppositories may be necessary to quiet the patient. In others, a mucilagenous suspension of bismuth subnitrate by rectal injection may be quite sufficient to soothe the pain. In general, however, this symptom is the exception rather than the rule and will be noted less and less frequently as precaution is observed in the protection of the rectum and bladder. Still less frequently is vesical tenesmus noted, and as a rule it is of a more evanescent type.

As to fistula, we have noted seventeen, nine recto-vaginal and eight vesical. By no means should all of these fistulae be charged to radium, for in over 200 cases of inoperable cancer which are not treated, this terminal event will certainly occur in a larger number of patients. We are convinced, therefore, that such distressing phases of cancer of the cervix are actually prevented, for in the large number of cases of deep ulcerating cervical craters, which were locally healed, there has been no further trouble in this locality, the patient ultimately dying of metastasis or deep pelvic extension.

Briefly stated, therefore, we see in the use of radium in inoperable cases of cancer a greater tendency to relieve pain than to produce it, and also a smaller percentage of fistulae after its use than in the patients going to their death untreated, or after various palliative operations have been performed or the actual cautery has been applied. Through the results achieved by radiation in this group of inoperable cases the question is forced into the foreground: Shall we abandon the radical operation in all cases in favor of radiation? As yet, we cannot wisely answer it. Certainly the questionable operative case must be transferred to radium therapy. In the definitely operable case with a well-circumscribed area and no broad ligament extension, we still advise hysterectomy and follow this procedure in about fourteen days later with a 100 milligram application of radium for twelve hours. We base this adherence upon the certainty of a definite percentage of cures obtained through surgical intervention. On the other hand, the transfer of the questionable case to the less drastic procedure is based upon the certainty of a large surgical mortality, the frequency of disabling sequellae and the distressingly high percentage of recurrence after even the most radical operation.

Thus far we know that radium effectively supplements surgery, and within the next five years it may possibly supplant the radical operation in even the early case.

Finally, as to the question of operation after radium has reduced the inoperable to apparently an operable stage: Upon this issue we find no reason to change our position as formerly expressed, for there is no convincing argument in favor of this plan. We feel convinced that surgery can accomplish nothing further: on the contrary, we believe that surgical intervention is most hazardous. The connective tissue contractures in the vaginal vault and parametrium incident to radiation must render the dangers of injury to the bladder, ureters, and rectum greater, and the disruption of connective tissue which may actually have

encapsulated the carcinoma may lead to a reimplantation of malignant cells, which may have been held in leash or have actually been rendered inocuous. On the other hand, in the positively operable cases we commend the plan advocated by Howard Taylor. He radiates all operable cases a few days before hysterectomy is performed. This appears most logical, for he intervenes before the actual destructive changes have taken place and in his experience finds no increase in the difficulty of a panhysterectomy. This, however, is a very different proposition from that offered after a deep crater has been apparently healed and upon its site dense hyalinized tissue has formed which drags the base of the bladder, ureters and rectum into close juxtaposition.

TECHNIQUE

As to technique, we have not varied from that described in preceding articles. One hundred milligrams are applied at one sitting and repeated at a second interval six or eight weeks later. If no improvement is noted after the second sitting, we make no further application, as we have seen no benefit accrue from a third treatment when the two preceding have failed.

Our technique is a simple one. The silver or platinum radium containers, as they come from the radium laboratories, are encased in black rubber drainage tubing, carefully tied at both ends. The site of the cancer must be exposed with one or two Syms' specula, as necessity demands. Usually a gauze tampon which forms a buffer between the rectum and the cancerous area is carefully applied and upon this the radium tubes rest transversely to the axis of the vagina. Above, the radium gauze is further packed to protect the bladder, followed by a liberal but not uncomfortable gauze tampon within the vagina. Frequently the vaginal vault may be much more expeditiously exposed by placing the patient in the Syms' or knee-breast posture. Indeed, in some instances, the latter posture greatly facilitates the more accurate placing of the radium tubes. The patient usually remains in the hospital one or two days.

In only one case has anything untoward occurred immediately after the application. This patient was greatly depleted by hemorrhage, and a deep crater under the bladder was present. Soon after radiation she developed all of the active symptoms of uremia and died in coma within a few days. This is the only instance in all of our series of any atypical phenomenon, and in view of the fact that many of these advanced cases die within a month or so after radiation from the ultimate results of the disease, we see nothing noteworthy in this one event.

The second application is made in the same way. Subsequently we try to see these cases or secure a report from the family physician or the patient every three months.

From our summary of 209 cases, we find no cause for discouragement, for we have seen splendid palliative results from radiation, and we hope that with a further development of technique, cancer of the cervix may be removed from the surgical domain. In this possible transfer we are sure we shall find few dissenters among surgeons, for certainly we have no grounds for optimism from a radical operation in the pathetically small percentage of operable cases. For every case which may with reason be submitted to operation at least ten will fall by the wayside because they apply for help too late. To these wretched sufferers radium offers a palliative boon and even a possibility of cure. In cancer of the fundus the results in favor of hysterectomy are too satisfactory to be jeopardized by the use of radium, although in at least four cases we have witnessed a very favorable outcome in patients in whom there were grave contra-indications to surgical measures. In two instances a cure appears to have been effected. For patients, therefore, suffering with complications prohibiting an operation radiation offers a decided hope, for in no anatomic situation may we so certainly secure the full force of the radium without ill results. The emanations are confined to the fundal cavity and the muscular uterine walls

shield other organs from injury. Thus far, there has apparently been no attempt to find a uniform plan of application, each reporter has apparently been no attempt to find a uniform plan of procedure, each reporter of his experience having followed a method differing from his colleagues. It seems to us that this Society should take cognizance of this matter and appoint a committee to bring forward standardized suggestions.

RESULTS OF RADIO-THERAPY IN 209 CASES OF CANCER OF THE FEMALE GENITO-URINARY ORGANS

1914

Living

4 years 4 months	1

Dead

2 Months	1
5 months	1
6 months	1
12 months	1
21 months	1
2 years	2
3 years	1
	8

1915

Living

3 years 3 months	1
3 years 10 months	1
3 years 6 months (urethra)	1
4 years (chorio epithelioma)	1
	4
No report	1

Dead

3 months	2
5 months	1
6 months	1
4 months	1
12 months	3
10 months	2
13 months	1
20 months	1
4 years	1
4 years 2 months (Died from T. B.)	1
2 months (Labia)	1
19 months (Vagina)	1
19 months (Urethra)	1
2 years 4 months (Vulva—Died from endithelioma of lung—no local recurrence)	1
Carcinoma of fundus—died from heart failure few months after application	1
	19

1916

Living

2 years 5 months	2
2 years 9 months	2
2 years 10 months	1
3 years	1
3 years 1 month	2
3 years 3 months	2
3 years 6 months	1
	11
Well for 22 months and then not traced	1
Well for 5 months and then not traced	1
Well for 2 yrs. and 4 mos. and then not traced	1
Well for 1 yr. and 2 mos. and then not traced	1
Well for 2 years and then not traced	1
Well for 2½ yrs. and then not traced	1
Well for 2 yrs. and 5 mos. and then not traced	1
Well for 3 years and then not traced	1
	19

Dead

1 month	1
3 months	4
4 months	2
5 months	3
6 months	4
7 months	1
8 months	3
9 months	1
10 months	1
12 months	5
13 months	3
14 months	4
18 months	2
20 months	1
21 months	2
19 months	2
2 years	2
2 years 2 months	1
2 years 3 months	2
1 year 8 months (fundus—death from cerebral embolus)	1
6 months (vulva)	1
	46

1917

Living

3 months	1
4 months	1
5 months	1
6 months	1
11 months	1
12 months	2
14 months	1
15 months	1
17 months	2
21 months	1
2 years	1
2 years, 4 months	1
9 months (fundus)	1
16 months "	1
17 months "	1
18 months "	1
11 months (vagina)	1
16 months "	1
21 months "	1
Not stated	2
	23

Dead

4 months	5
5 months	3
6 months	2
7 months	2
8 months	1
9 months	3
10 months	1
11 months	1
12 months	2
13 months	4
14 months	1

17 months	1
26 months	1
5 months (vagina)	1
11 months (fundus)	1
12 months (fundus)	1
11 months (urethra)	1
14 months (vagina)	1
Not stated	1
	33

1918

Living

1 month	1
2 months	6
3 months	1
4 months	2
5 months	2
7 months	2
8 months	5
9 months	1
10 months	1
11 months	1
12 months	2
14 months	2
3 months (fundus)	2
11 months "	1
12 months "	1
4 months (vagina—following hysterectomy)	1
12 months " " "	1
14 months " " "	1
12 months (choro epithelioma)	1
	34
No report	13

Dead

2 months	1
5 months	1
9 months	1
10 months	1
11 months (fundus)	1
	5

Hemorrhage

Stopped	132
Lessened	26
Uninfluenced	13
Not stated	38
	209

Malodorous Discharge

Stopped	85
Lessened	26
Uninfluenced	28
Increased	14
Not stated	56
	209

Pain

Relief	49
Unrelieved	34
Lessened	8
Not stated	118
	209

Fistulæ

Vesico-Vaginal	8
Recto-vaginal	9
	17

THREE YEARS' EXPERIENCE WITH RADIUM IN CANCER OF THE UTERUS*

BY ERNEST CHARLES SAMUEL, M.D.

Radium Institute of New Orleans

NEW ORLEANS, LA.

THE Radium Institute of New Orleans was founded for the purpose of using radium for the cure and relief of patients when, in the judgment of the members of the institute, radium was indicated. We have at our disposal at Touro Infirmary a special section of the hospital where three patients are taken during the day and three at night, so our supply of radium is always at work.

In the last two years, I have limited my exposures for malignancy of the uterus to twelve hours, not using over 50 milligrams of the element, the dosage being 600 mg. hours for each treatment. My first year was very disastrous—I think I was over-enthusiastic, using 150 mg. of the element for 12 hours and in a few cases for a longer time. Seeing the marked benefit from the smaller dosage, I thought larger doses and heavier screening would accomplish better results. It took me about one year to get my bearings. After seeing quite a number of fatalities which I knew were due to overdosage, I wish to make the plea before this meeting for *smaller* doses and at least a ten-day interval between exposures, filtering more at each exposure and stopping for four weeks at the end of the third exposure. I have been able to accomplish just as good results with this method as I did with the larger dosage, and with more comfort to the patient. The patients are not toxic after the smaller dosage; the bladder symptoms, I was having, are eliminated; no proctitis is seen—all of which we know make the patient more miserable than does the growth. I generally give three cycles of three treatments each with, as stated before, four weeks' rest after each cycle. At the end of three months the treatments are resumed. A piece of tissue is always removed or a diagnostic curettage is done before the treatments are begun; no cases are received unless they will submit to the procedure. At the end of three months, a piece of tissue is again removed, if possible, and studied by the pathologist. While I realize this does not mean much in the prognosis, because in the large majority of cases that we see, the parametrium is undoubtedly involved, it acts as a control to further treatments.

There is no doubt that the wide publicity that has been given the subject has done some good in leading patients to consult the doctor earlier; but I am sorry to say the profession is largely to blame for the hopeless, inoperable cases that we see daily. Of the patients who apply to us for treatment, at least 80 per cent are already in the inoperable stage; quite a few will give a history of having consulted their family physician and having been given a douche; in other cases ergot was prescribed and they were told it was the "change of life," and not even a vaginal examination was made. When the doctor finally discovers the true condition and the patient is rushed to the surgeon or the radiotherapeutist, and when surgery or radium fails, both are condemned.

The entire problem that must be considered in successful treatment of carcinoma of the cervix must be based upon the invasion of the new growth. The radical operation has proved that the hopeless cases are those of the metastatic type, and everything must be directed toward the local vaginal and cervical disease; if the growth has invaded the parametrium and around the uterus also—if the iliac glands are involved —the case must be considered hopeless and radium gives the greatest percentage of re-

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

lief to the patient, controlling the local disease, stopping the discharge, pain and hemorrhage.

The operable cases are operated on without delay, and though radiation is given just as soon after as possible, with radium and deep roentgen therapy, we do not give a preliminary treatment before operation, as the operators have found considerable difficulty with the tissues that have been radiumized. It is very difficult to control hemorrhage, as the parts are very friable; even the cases that are inoperable when first seen and by treatment are apparently rendered operable, are let alone. Recently Kohlmann, in the Gynecological Service at Touro Infirmary, has been making an abdominal section and tying the iliacs, and, as soon as the patient is over the surgical shock, radium has been introduced into the vagina and been placed against the growth in the usual way; the cases seem to do better by this plan. He is working along the old theory of cutting down the blood supply to the parts and assisting radium in that way.

Radium, in our hands, has offered the most helpful outlook for the palliation and, occasionally, for the cure of cancer of the uterus; but I think the majority of the profession expect too much in the form of absolute cures. Such has not been our experience; in fact our results are disappointing, as only a small number of our cases have remained well for over two years. All the patients apparently do very well for the first eight to twelve months, and during this time it is very hard to find any evidence of the growth by inspection—vaginal or abdominal palpation. They will start to complain of vague abdominal pain; upon examination we find marked evidence of a recurrence, and in our experience it is useless to resume the use of radium, as in the majority of cases it is like adding coal to the fire. Why the carcinoma cells act in this way I have not been able to explain; deep roentgen therapy seems to offer more in a palliative way at this stage than does radium.

I regret to have to report the results of our observation in this particular field as I must admit I expected more. Reports from other clinics are more encouraging, I think, than ours—why, I do not know!

There is a wide divergence of opinion among our workers in regard to the proper dosage, and I hope this Society will take steps toward a standardization of some method that we can adopt, especially in regard to the amount to use and the length of exposure. Screening has become fairly standard, brass being the one of choice.

The youngest patient treated for malignancy of the uterus was twenty-four years old. We were able to control the growth for a while but, as I said before, I was too enthusiastic and gave her 3,200 mg. hours in three treatments; she developed a septic diarrhea and died in ten days. No postmortem was allowed. Our oldest patient was seventy-nine years old; I gave her only one treatment of 425 mg. hours and she improved wonderfully and is alive to-day—that was one year ago. The next oldest was seventy-eight years old with a growth in the cervix; I gave her 2450 mg. hours in four treatments and she is well to-day. The patients beyond 60 years old seem to do better. Our average age has been between 45 and 55, and the average duration of life, after radium treatment was begun, has been 18 months to two years. The cases treated with the Percy cautery do not do well with radium treatment, as they are already toxic and any addition causes trouble. The average number of treatments given was six in two cycles of three each, using 50 mg. for twelve hours, which gives 3600 mg. hours.

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
71648	48	Hemorrhage after menopause	Cauterized with Percey cautery; vesico-vaginal fistula as a result, recurrence in vagina	1500	3	Improved; no late reports

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
58758	59	Has a bloody discharge, noticed for three mos. Operated, March, 1917, Panhysterectomy	Operated March 1917 for carcinoma. Panhysterectomy	1500	3	No recurrence to Dec. 1918; no later report
57311	49	May 1916 noticed a vaginal discharge which became bloody and foul	Panhysterectomy Aug. 1916, recurrence in vaginal wall and bladder	3025	3	Improved. Growth did not disappear. Patient died 8 mos. later
73446	39	Watery vaginal discharge for one year. Very foul odor; large fungating mass.	Local application	1400	3	Discharge stopped, feels better, has gained weight. Coming for further treatment
73560	62	Hemorrhage, vaginal discharge, broken down cervix	Iliacs tied	500	1	To return for further treatment
68791	48	Hemorrhage one year ago	Cauterized	1000	2	No improvement; died one month later
58199	70	Nov. 1, 1916, had hemorrhage	Curetted—large fungating mass in vagina	2500	4	Very much improved at last examination. No late reports
53448	58	Loss of blood first noted June, 1915, continued up to operation on Jan. 28, 1916. Hysterostomy	Hysterotomy	2575	6	Well for 8 mos., return of symptoms, death at end of 12 mos.
72851	51	Loss of weight, bloody discharge treated for two years, local application		500	1	Died at end of two weeks
60168	47	Dec. 1916, had a pinkish watery discharge, latter very profuse and foul. Then a flooding spell	Cervix cauterized 20 yrs. ago for ulceration	2200	4	Symptoms controlled for 1 yr. return of growth in vagina, no response to inquiry
56461	61	Aug. 1916 vaginal discharge, dark like coffee stains which continued. Admitted for radium Nov. 3, 1916.		10575	14	No discharge, unable to find trace of growth. Last treated Nov. 4, '17.
65968	49	First noticed hemorrhage Often having a foul vaginal discharge for six months		5300	10	Symptoms controlled for 8 mos. Local recurrence in vagina. Still alive
72014	45	Hemorrhage Nov. 20, 1918		1500	3	No return of hemorrhage, no evidence of growth, unable to get reports
71759	51	Bloody vaginal discharge, very foul, for three months		1000	2	Improved at last report
68161	39	Hemorrhage	Local treatment	1000	2	No report
53757	69	Vaginal discharge, slight odor, had hemorrhage following douche	Curetted and cauterized	9275	10	Patient first treated in June 1916. At last examination Dec. 1918, no evidence of growth
64878	67	First noticed bleeding when at stool, gradually increased until large clots were passed	Panhysterectomy	4000	5	Patient was well for 1 yr. returned with growth in ligaments. Going down rapidly

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
60236	33	Vaginal discharge followed by hemorrhage	Panhysterotomy	1100	1	No report
69390	43	Yellowish discharge, no odor, followed by hemorrhage	Abdominal operation, does not know what was done	4500	9	Very well for 18 months. No report since
73157	59	Noticed a bloody discharge, very offensive, inoperable	Local treatment	700	2	No report
64330	49	Watery discharge. Streaked with blood	Operated upon; does not know what was done	1100	2	Temporary improvement; no report after 2 mos.
60060	27	Pain in back, white discharge, became bloody	Panhysterectomy	825	1	No report
63843	49	Bloody discharge	Hysterotomy	550	1	No report
66740	57	Bloody discharge, followed by hemorrhage	Hysterotomy	1600	3	At last examination slight infiltration in vaginal scar, no symptoms
70026	44	Frequency of urination Vaginal discharge	Amputation of ulcerated cervix	2000	4	No return of symptoms
57259	43	Hemorrhage, large growth of cervix	Curetted	4000	6	No evidence of growth at last examination
63372	70	Vaginal discharge 30 yrs. after menopause, followed by hemorrhage, large mass	Local treatments	1500	2	No report
66900	67	Hemorrhage, stopped for a while from use of douches prescribed by doctor, large mass	Local treatments	1500	3	Very much improved. No late reports
71501	39	For past 18 mos. has had a yellowish discharge, then followed by hemorrhage	Operated on out of city. Does not know what was done	10000	10	Temporary improvement, involvement of rectum later. Death at end of 10 mos.
71839	68	Bad vaginal discharge, very foul odor, followed by hemorrhage	None	2000	3	Very marked improvement in symptoms; last examination no evidence of growth
73491	55	Developed bad vaginal discharge with hemorrhage; not examined until admitted to hospital—large fungating mass	None	25000	6	Temporary improvement lasting 6 mos. Vague pain in abdomen, abdominal metastis
59585	69	Bearing down pains in lower abdomen; frequent urination followed by bloody discharge	Hysterotomy	2500	4	Improved for 8 mos. Return of growth in vaginal scar. Died
68299	37	Watery discharge on examination, large ulcer of cervix, diagnosis from scraping malignant	Local treatments	1500	2	Ulcer healed. No report from patient
58251	47	Foul vaginal discharge with hemorrhage	Local treatments	5500	4	Marked improvement. No evidence of recurrence for 3 mos. Patient died from uremia

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
61285	48	Eight months before noticed a white discharge, vile odor, became large	Percey cautery	3000	6	No result as patient had a vesico-vaginal fistula from cautery. Died in three mos.
68358	26	Vaginal discharge. Streaked with blood. Large mass in cervix	Operated on; thinks growth was removed from cervix	1700	3	No report; did not return
73359	37	Constant watery discharge streaked with blood	Cervical operation one year ago, no result, internal iliacs tied	2200	3	Doing very well. Has not reported in last 4 weeks
71192	57	Pain in lower abdomen and burning in vagina; large ulcerated cervix	Local treatment	1500	3	No evidence of growth on cervix; patient later reported considerable trouble with bladder. No evidence growth
63919	52	Bladder irritation, vaginal discharge, large mass in vagina	Local treatment	1100	3	No report
55505	64	Vaginal discharge for three years, became bloody	Local treatment	2800	3	No reports
64796	50	Watery vaginal discharge, very foul. Become bloody followed by hemorrhage	Local treatment	1100	2	No report
73095	68	Vaginal discharge, which became bloody, large mass in vagina from cervix	Local treatment	2300	3	Condition very much better. Last examination still shows evidence of growth
56377	48	Greenish yellow vaginal discharge followed by bloody discharge; large foul mass in vagina	Vaginal operation; does not know what was done	4075	4	Patient remained well for 2 yrs. Returned recently with large mass in abdomen — going down rapidly.
59439	54	Pinkish discharge followed by bleeding	Hysterectomy	4000	7	At last examination patient very much better. No late reports
64230	50	Vaginal discharge followed by hemorrhage	Panhysterectomy	3500	6	At last examination found patient very much better. No symptoms at last report
68236	62	Bloody discharge	Local treatment	1600	3	Patient's condition at last report satisfactory
62950	39	Bladder irritation; vaginal discharge	Panhysterectomy	1100	2	Vesico-vaginal fistula; evidence of carcinoma. No effect of radium
57993	47	Vaginal discharge, became bloody.	Panhysterectomy	1100	2	No report
55921	53	Vaginal discharge followed by hemorrhage, large mass in abdomen	Local operation on cervix	1200	1	No result, death in 2 mos.
59980	52	Offensive watery discharge, became yellowish, noticed some blood	Percey cautery	5000	6	Patient was full of symptoms for 6 mos., growth returned in vagina. Death at end of 12 mos.

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
56465	43	Bearing down pain in abdomen, large hemorrhage with clots	Panhysterectomy	20000	4	No result from treatment. Very toxic after large doses. Infiltration of rectum. Death in 6 mos.
63724	55	Discharge, followed by hemorrhage	Panhysterectomy	15600	14	Temporary improvement, Infiltration of rectum and bladder. Patient at last report doing very badly
64861	45	Frequency of urination, long periods ulceration of cervix, specimen showed malignancy	Local treatment	3000	5	Marked improvement for 6 months. Return of growth in broad big amount, patient going rapidly down
73329	51	Discharge followed by hemorrhage	Panhysterectomy	1000	2	Unable to get reports
60953	55	Bladder symptoms followed by hemorrhage	Panhysterectomy	3000	4	Patient has remained well for 18 mos. Last report no symptoms
69840	38	For two years had yellowish discharge, was given douche, not examined, followed by hemorrhage from fungating mass	Vagina cleaned out	1000	2	No result patient died in 3 months
55783	39	Vaginal discharge for 3 months becoming increasingly blood-tinged. No pain	None	1912	3	Marked improvement generally and locally
67253	60	Bloody vaginal discharge beginning three months ago. Several profuse hemorrhages. No pain	None	1400	3	Bloody discharge decreased
58769	42	Ten months ago began with vaginal discharge bloody in character becoming constant. Pain in lower abdomen	During course of treatment panhysterectomy, ligation of iliacs	3520	5	General condition improved. Bleeding stopped
69062	59	Bloody vaginal discharge during past six months	None	1500	3	Discharge decreased
63298	49	Three weeks ago began to have bloody discharge	Panhysterectomy	2640	4	Bleeding lessened
62686	39	Continuous vaginal discharge during past year bloody and foul. Profuse hemorrhages at intervals	None	1350	2	Bleeding checked
60081	56	Bloody vaginal discharge beginning six months ago. Offensive odor. No pain	None	4995	10	Discharge distinctly improved, also general condition
57794	60	Pain in lower abdomen, bloody discharge, later becoming watery, bleeding recurred after operation	Nature of previous operation unknown	2040	3	General condition and discharge improved

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
72858	48	Continuous uterine bleeding with yellow discharge, frequently passes large clots of blood	None	1500	3	Improved
71681	38	Slight bloody discharge following operation 4 months ago. Pain in lower abdomen and back	Curettage	2950	4	Improved
58292	42	Metorrhagia and menorrhagia beginning two years previous. Pains lower abdomen, loss of weight	None	1075	2	Unchanged
56357	45	Pain in abdomen and back. Bloody discharge during past year becoming more and more profuse	Cautery treatment	2610	2	Unchanged
57019	33	Continuous bloody discharge	Amputation of cervix	2140	2	Died
68035	54	Pain in abdomen and back, ulcerated cervix	Ligation of int. iliacs	523	1	Unchanged
69492	43	Small vaginal tumor. Slight bleeding	None	3200	5	Bleeding decreased. Tumor decreased in size
62312	64	Bloody vaginal discharge beginning 18 months ago. Abdominal pain marked	None	3205	5	Amount of discharge lessened. Pain controlled
59211	32	Intermittent bloody vaginal discharge during past 7 yrs. becoming more profuse and more foul. Abdominal pain	None	4750	8	Discharge markedly improved. General condition improved
65652	61	Intermittent bleeding past 15 yrs. Recently has had several hemorrhages. Pain in right side	None	1840	4	Bleeding decreased in amount and frequency. Pain controlled
68385	51	Vaginal discharge past 7 yrs. Becoming blood-tinged during past year. Profuse and foul at present	None	2300	4	Bleeding is lessened
60522	35	Vaginal discharge began 2 mos. after operation, becoming blood-tinged. Marked lower abdominal pain	Panhysterectomy	1700	3	Local and general condition improved
61716	54	Hemorrhage 7 mos. ago. Intermittent bleeding since. Some odor to discharge	None	4335	7	General and local condition decidedly improved
59931	70	Two months ago had a severe hemorrhage and there has been continuous bleeding since	None	5350	7	Temporary improvement in discharge

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
61111	45	Intermittent bleeding—marked odor	Curettage	2030	4	Discharge controlled
68879	53	Continuous bloody discharge, no pain	None	2900	4	Bleeding markedly checked
65348	33	Profuse vaginal discharge, slight odor, very little blood	None	4075	8	Very marked local and general improvement
59872	59	Offensive vaginal discharge becoming bloody during past year. Path-adeno-carcinoma	None	6080	10	Great general improvement, also locally
60184	65	Severe hemorrhage 3 weeks ago which has continued since though less in amount	None	3975	3	General condition improved
71748	35	More or less continuous bleeding—Path. carcinoma simples	None	2100	4	General and local improvement.
61784		Slight vaginal discharge	None	1200	2	Improved, unable to hear from
57944	40	Almost continuous bleeding, checked temporarily by operation but reappearing. Pain	Operation not known	750	1	Improved
57551	64	Yellowish vaginal discharge beginning 5 mos. ago, becoming bloody. Bloody with foul odor now, moderate pain	None	2125	3	Improved
62001	54	Profuse discharge began 2 mos. ago, foul odor. No pain	None	2950	3	Improved
67054	50	Profuse bloody vaginal discharge—large fungating mass	None	2700	3	Died
66336	79	Vaginal discharge during past year, foul, bloody; no pain	None	425	1	Improved
56753	46	Profuse bleeding 2 mos. large ulcerated cervix—bleeding not constant—no odor	Exploratory showing extensive infiltration	9485	8	Improved
67040	44	Since operation one year ago has had vaginal discharge. Later has become odorous and bloody	Panhysterectomy one year ago	2975	5	Discharge temporarily decreased.
63138	47	Irregular bleeding past 10 months, pain in left abdomen. Uterus large and hard. Carcinoma of cervix by P.D.	None	1025	2	Discharge is lessened
62491	71	Five months ago slight bloody discharge. Began becoming worse. Clinically cervical carcinoma	None	2575	4	Discharge lessened; local condition improved

No.	*Age*	*Symptoms*	*Previous Treatments*	*Mill. Hours*	*No. of Treat.*	*Results*
62685	41	Almost continuous bleeding during past five months. Foul odor to discharge. Pain in lower abdomen	None	1625	3	Discharge markedly decreased
64764	66	Path. diag. carcinoma of cervix. Vaginal discharge beginning three months ago	None	1900	3	Discharge ceased. Local condition improved
64903	78	Bloody discharge during past 2 months. Considerable lower abdominal pain	None	2450	4	General condition improved
67523	51	Bloody vaginal discharge began 7 months ago. This has become more marked	Cauterization	550	1	Discharge decidedly decreased
64500	42	Painful urination. Constant moderate bleedings. Slight vaginal pain	Operation, nature unknown	3275	5	Bleeding decreased
61359	51	Loss of weight during past 8 months. Bloody vaginal discharge	None	1950	4	Decrease in vaginal discharge
55321	47	Pain in rectum beginning two years ago. One month ago bloody vaginal discharge began	None	8400		Condition temporarily improved permitting hysterectomy. Eventual death
57648	42	During past three months bloody vaginal discharge has increased. Abdominal pain	None	2637	4	Decided improvement in vaginal discharge
62287	40	Intermittent bleeding, cervical tissue shows adeno-carcinoma	Hysterectomy during course of treatment	3625	6	Bleeding checked
71161	43	Yellowish vaginal discharge; no odor	Panhysterectomy three months ago	1000	2	Discharge lessened
64887	58	Slight vaginal discharge beginning 5 months previous	Removal of fibroid 5 years ago. Cauterization	1100	2	Discharge lessened
58086	45	Continuous bleeding of small intensity during 4 months. Pain in lower abdomen and vagina. No urinary disturbances.	None	1312	2	Improved
67385	61	Occasional bleeding. Slight vaginal discharge. Slight abdominal pain	*X*-ray	500	1	Improved
59131	43	10 months began to have slight bloody discharge. During past 2 months flow has been constant. Abdominal pain.	Iliacs and ovarian tied	5125	8	Flow reduced in amount
66058	54	Yellowish vaginal discharge began one year ago, becoming offensive in odor and more constant. Occasional pain	Five years ago, panhysterectomy	1550	3	Pain relieved. Flow decreased in amount

No.	Age	Symptoms	Previous Treatments	Mill. Hours	No. of Treat.	Results
55835	43	Constant abdominal pain during past 3 months. Vaginal discharge becoming odorous, occasionally bloody	None	6440	7	Marked temporary improvement followed by death
60371	33	Abdominal pain	Panhysterectomy. Ligation of int. iliacs. Diagnosis pathologic carcinoma	2575	5	Marked improvement in local condition.
55353	34	Intermittent bleeding after exertion, abdominal pain increasing. Also constant bleeding	Operation; nature unknown	4500	6	General and local condition improved
59523	70	Abdominal pain. Bloody vaginal discharge. Irregular	None	5125	8	Improved
71649	56	Profuse vaginal discharge, bloody in character	Three previous applications	1500	3	Improved
68330	67	Profuse bleeding following cervical cauterization	Cauterization of cervix	500	1	Improved
56042	51	Profuse bloody discharge Pain in abdomen. Discharge now has odor	None	3225	1	Improved
66252	34	Slight bloody discharge at first, now yellowish in character. No pain. Cervix eroded	None	6900	8	Improved
57610	35	Profuse bleeding. Uterus enlarged, hard and tender. Pain in left side	Amputation of cervix. Another operation, character unknown	2100	3	Improved
50954		Slight bloody discharge.	None	3600	2	Improved
	36	Bloody vaginal discharge followed by hemorrhage	Panhysterectomy	8210	11	Patient was very much improved for 18 mos. Return of growth; died
67995	45	Bloody vaginal discharge.	Panhysterectomy	475	1	No report
54090	24	Vaginal discharge. Large mass in uterus and cervix	Mass cleaned out	3200	3	Patient did very well; became septic, probably too much radium; died
54776	44	Bearing down pains and vaginal discharge; followed by hemorrhage—vaginal fistula	Mass removed	1575	1	Patient became septic, probably from radium; died
71760	55	Small tumor mass in vagina, intermittent bleeding	None	2700	2	No report
57141	39	Bloody vaginal discharge past two years. Watery discharge after operation	Panhysterectomy one year ago	2650	5	Patient did well for 15 months
66872	44	Bloody vaginal discharge.	Panhysterectomy	2750	5	Did well for 10 months then had recurrence

THE BIOLOGICAL REACTION OF CARCINOMA CELLS PRODUCED BY RADIUM RAYS. THE TECHNIQUE OF RADIUM THERAPY IN GYNECOLOGY*

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A STUDY of the biological reaction of tissues to radiation enables us to interpret correctly their therapeutic value and assists us in the choice of the quantity and quality of rays to be employed.

Since the therapeutic action of radium is not only local but is also general or constitutional, a correct knowledge and interpretation of the local and systemic reactions are necessary and very important. Clinical observations of the latter furnish a guide to the determination of indications and contra-indications to radium therapy.

Not only that—a knowledge of the biological as well as the therapeutic, i.e., local and systemic reactions, will materially aid us in the correct development of the technique for the application of the rays and in the probable prognosis of radiation treatment.

We must always realize that success in cancer treatment can be attained only by the total eradication or degeneration of all cancer cells present in the body of a victim of the disease. This principle must be observed if we are to expect results, whether the means chosen are surgical or radiological. The danger in the treatment of cancer with surgery consists in the fact that we cannot always remove all tumor tissue. The vestiges left grow after such treatment with an increased rapidity, and by auto-transplantation cause secondary growths in different parts of the body. The danger in the treatment of cancer with radio-active substances arises from the fact that proliferation is enormously stimulated if we cannot rapidly destroy all the pathological cells. An accelerated proliferation increases the danger of the formation of metastases.

H. Dominici has made extensive and valuable researches of the biologic action of radium rays. He applied 100 mg. of pure radium sulphate in a flat applicator of 5 sq. cm. to the skin of a healthy animal. Within three weeks after the application he observed three varieties of change. The epidermis and cutis which had absorbed all of the alpha and soft beta rays showed a necrosis and destruction of these structures. The subcutaneous tissue and fasciae which were subjected to the action of the medium beta rays were undergoing an intensive proliferation and retrogression to the embryonic state. The hard beta and gamma rays had become absorbed in the aponeurosis, muscle and even osseous tissues which evidenced metabolic changes. In from five to six weeks after the application of the radium the epidermis and cutis had regenerated, while the other tissues did not return to a normal state for from six to eight months.

This observation demonstrated the variety of action of radium rays: necrosis, stimulation of cell proliferation, embryonal retrogression, and metabolic changes. It also showed the different behavior of various elementary cells toward the rays, which was termed by Dominici "receptivity" or "sensitiveness," and by Colwell and Russ "selective absorption." Based on these facts Bergonié and Tribondeau formed the law that "immature cells, and cells in an active state of division are more sensitive to rays than are cells which have already acquired their fixed adult morphological or physiological characters."

The degree of selective absorption of rays by the living cell depends upon the particular phase of its life cycle, its species, as well as the age of the host whom it inhabits. Cell elements which are embryonal or undifferentiated are destroyed by a radiation which would cause only a slight reaction in the

*Read at the Third Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5, 1919.

surrounding mature or highly differentiated cells. The basal cells of the epidermis and hair follicles, lymphoid cells and sex cells (as ova and spermatozoa) are readily killed by an amount of rays which would leave intact the neighboring mature cells.

Selective absorption also depends upon the species of the cell, whether epithelial, connective tissue or endothelial; and on the different varieties within each species. Normal connective tissue cells are less receptive than normal epithelial cells. Epithelial cells of the basal layer of the skin are less sensitive than those of the papillæ of the hair follicles, although they are different kinds of the same species. Lastly, the tissues of a child are much more easily altered by radiation than corresponding tissue elements in the adult.

These observations made on normal cells apply with equal force to abnormal cells and tissues, neoplastic as well as inflammatory.

Remarkable examples of radio-sensitive tumors are ectodermal and basal-celled epitheliomata derived from the basal-celled layers of the epidermis, lymphadenomata originating from the embryonal lymph cells, sarcomata derived from embryonal connected tissue cells in which the connective tissue fibrillæ, cartilagenous and osseous tissues have undergone re-absorption, fibromata in which the fibroblasts are present in large numbers and do not develop into highly differentiated adult cells, and connective tissue fibers.

On the other hand squamous-celled epitheliomata, fibrosarcomata, chondrosarcomata, osteosarcomata, and fibromata in which atrophic fibroblasts and abundant fibrous tissue have been retained, are very refractory to radiation.

The action of radium rays on neoplastic cells is of an impeding, destructive and evolutional character. The radiation arrests the growth of the tumors before it destroys them or renders them harmless by an evolutional process or metaplasia. Arrest of growth results from a cessation of the function of mytosis or genocepter. Destruction of tumor cells is either a direct or an indirect process. In the direct form the tumor cells undergo necrobiosis. The cytoplasm and nucleus disintegrate, and the cells are absorbed by phagocytosis. In the indirect destruction a metamorphosis of the tumor cells precedes absorption. This consists in a hypertrophy of the cells, enlargement of the nucleus, nucleolus and even centrosomes, so they appear like pseudoparasites, and achromatism, vacuolation and granulation of protoplasm.

The evolutional influence of radium on tumor cells is evidenced by a retrogression, or stimulation of the embryonic tumor cells as they develop to maturity. To understand this process we must have a clear conception of the formation, growth and function of a cancer cell. Tumor formation deprives the cells of their normal functions. They become "strangers" to themselves and to the mature normal cells from which they originate.

The growth of tumor cells is not only the result of a proliferation of a single embryonal cell group, but also depends on a retrogression or metamorphosis of normal mature cells to an embryonal phase after they have become included in the cancer tumor. By a process of evolution the embryonic abnormal cell is stimulated to grow and develop into a mature, highly differentiated normal cell, thus becoming benign.

Let us conclude with Colwell and Russ: Very rapidly growing cells are the most affected of any by radiations. However different rays give rise to quite different effects upon one and the same variety of cell, they have a "differential" action and a careful distinction should be made between the "differential" action which different rays have upon the same variety of cell, and the "selective" action which the same kind of radiation has upon the many different varieties of cells.

Microscopic examination of tissues exposed to hard beta and gamma rays reveals the following facts: Soon after exposure, a serous infiltration, an enlargement of the cell nucleus and cell body, and a swelling of the endothelial cells lining the capillaries are seen. The lumen of the latter decreases in

size. Within seven to eight days a degeneration of the cell nucleus is evidenced by a cessation of mitosis, a pyknosis, cytolysis and achromatism, while the protoplasma evidences vacuolation and granulation. A reactive inflammatory process also appears characterized by a lymphocyte and leukocyte infiltration and the appearance of numerous young fibroblasts. It seems as if the compact tumor masses break up in small particles separated from each other by this young connective tissue. The cell debris is rapidly cleared away by phagocytosis. The fibroblasts mature into connective tissue. It would appear as if the tumor had actually vanished. However this is not the case. On more careful examination, especially in regions more distant from the radium, epithelial cells are still seen, sometimes isolated, at other times in small nests that exhibit all stages of degeneration. Whether they are dormant or absolutely harmless or dead, of course, cannot be stated. However if radiation is not continued they may again assume renewed activity leading to a recurrence.

Prime considers that these degenerative processes affect the cell nucleus in preventing mitosis. Such radiumized tissue will not grow when inoculated in mice. Radium does not kill the cell outright, but injures the nucleus in such a manner as to prevent further division, which must eventually result in the death of the cell if its energy is expended in growth and division and not in a purely mechanical function.

TECHNIQUE

In America the Wertheim operation has never been distinctly popular because of the feeling that the additional cases saved by this method do not justify the higher mortality from the operation. From the economic standpoint it must be considered that a competent Wertheim operation is beyond the reach of the great majority of the population and that all the phases of the cost of acquiring technical skill should be counted in estimating its utility. Because of these considerations a marked change has occurred during the last few years in the aspects of surgical treatment of uterine cancer, most surgeons preferring to reduce the scope of operability, and others abandoning all operations for uterine cancer in favor of radium and *x*-ray treatment. Earlier diagnosis has doubtless contributed to improving surgical statistics and is equally important for radium therapy. In these directions lies the hope of real advance in the therapeutics of uterine cancer.

The demonstrable reduction in size of a tumor of a kind not to be attributed to the natural processes of evolution of that tumor or its associated lesions, is the one essential feature of effective therapeutic intervention. Circulatory changes in the tumor, the relief from pain, the restoration of a secondarily impaired function and local healing, cannot be cited as indications of the specific curative action of the agent employed. The growth may continue to advance in spite of their presence. We should exclude from consideration all these secondary factors. The observation of the size of the tumor itself is the sole criterion on which we can place reliance in judging of the effect of therapeutic measures.

Accordingly we have attempted to evolve the technique of radio-therapy. The latter may be profitably divided into two parts: the dosage and the technique of application.

Dosage is a complex quantity and includes the quantity of radio-active material, the volume in which it is contained, or the area over which it is spread, the nature of the rays selected, and the time during which they are applied.

The radium tubes should contain approximately 50, 35, 25, or 15 milligrams element. The filters used for internal work can be filled with any combination of these tubes up to 100 milligrams. The 15 milligram element of radium is contained in a platinum needle with an iridium point. It may be thrust into the tumor substance, for instance, through the perineum into a lobe of the prostatic gland under guidance of a finger in the rectum, or into the substance of the tongue, the cervix, the paracervical tissues, etc.

As the therapeutic action of radium extends for a radius of about 4 cm., from 50 to 100 mg. of radium element are inserted into the uterus, if that organ is the seat of a carcinoma. Should the uterine canal measure 3 inches in length, 75 mg. are deemed sufficient; if it measure 4 inches, 100 mg., and so on. The "bomb" may carry up to 100 mg. and is placed directly against the cervix and vaginal vault if an extensive involvement of the vaginal portion of the cervix and vault are present. The rays will cause a degeneration of carcinoma tissue within a radius of 1 cm. within eight hours, within 2 cm. within thirty-two hours and within 3 cm. within seventy-two hours, and so forth. Therefore a cervical or uterine growth is exposed to the action of the rays for seventy-two hours, 3 cm. being the average extent of an area which could be effectually influenced by radium rays. Extensive infiltrations of the parametria are punctured with a special trochar which enables us to bring the element directly into these masses. The tubes are left for a variable length of time corresponding to the extent of the area.

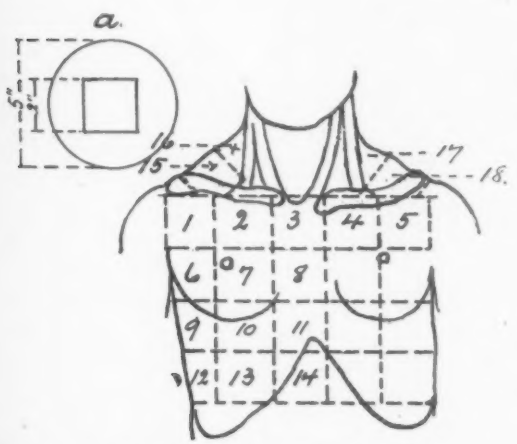

FIG. 1. Dotted lines indicate division of chest wall in roentgen treatment of carcinoma of the breast. Each field is 2 inches square. The lead disc "a" has a window of 2 inches square in center and a diameter of 5 inches, the same as the compression tube. The thickness of the plate is 5 mm. The arrangement posteriorly is the same.

The arrangement of the capsules is as follows: The radium is contained in silver or brass capsules of a wall thickness of 0.5 mm. These capsules are inserted into a filter made of brass of a wall thickness of 0.7 mm. The filter is then surrounded by a rubber tube (fountain pen filler) of 3 mm. thickness. A thread is attached to the filter cap, which is secured with a safety-pin to an abdominal binder.

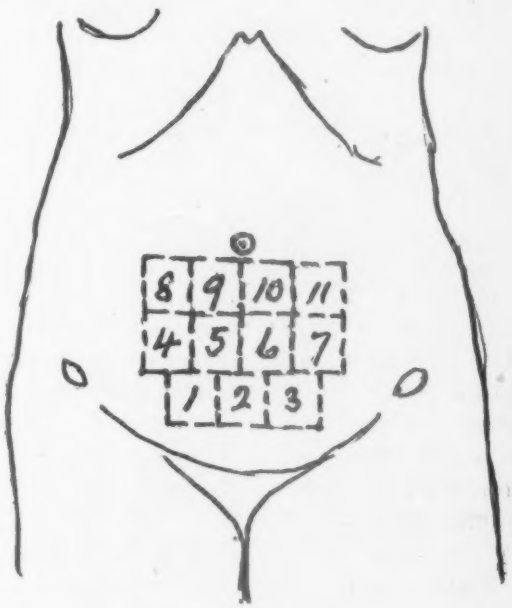

FIG. 2.

In noting results we observe: (1) the arrangement of the radium capsules; (2) the distance of the capsule from the tumor tissues; (3) the method of filtering; (4) the duration of each séance; (5) the interval between séances; (6) the histological structure of the tumor, if biopsy is advisable; (7) the comparison by examination of the actual size of the tumor preceding each séance of treatment; (8) the visible effects of radium on the tissues, as erythema, burns and so forth; and (9) daily examinations of the blood, including a differential white count. These are of importance to interpret correctly the latent action of radium on tissues and constitution and to determine the curative or palliative efficiency of the agent.

We observed in our earlier work that though we obtained a local regression of the

tumor evidenced by local healing, reduction in size of the growth, normal findings on palpation as to position, movability, size, form, consistency and sensitiveness of all the generative organs, the growth would continue to grow or reappear with undesirable frequency at its periphery. Evidently the rays did not destroy the distant parts of the tumor. To overcome this difficulty we resorted to a simultaneous use of the

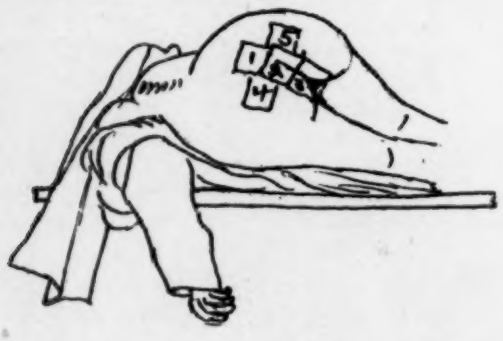

FIG. 3.

roentgen rays, and have found in them an effective means of combatting the peripheral spread of the tumor.

The technique of the roentgen rays therapy has been rendered so exact in its minutest details that carelessness or neglect are impossible. The best description is furnished by the reproductions of Figs. 16, 17 and 18. To each square 50 milliampere minutes are applied. The Coolidge tube must take a spark of nine inches, the milliamperage being 4 to 5; the rays are filtered through 0.5 mm. of zinc or 3 mm. of aluminum; the secondary rays forming in the metal filter are arrested by the distance between it and the body surface, it being placed about half way between tube and body surfaces. The distance of the anode from the body surface is 21 cm. With such an arrangement we obtain about 6 E doses, i.e., 30 X or 15 H, within 10 minutes, if the pastille is placed above the filter and 1E if it is placed on the skin surface. According to Bumm's researches, 3 to 5 E doses will destroy carcinoma tissue within one centimeter from the body surface, but it takes 7 to 10 times this amount to obtain similar results near the posterior bony pelvic wall, the seat of the glandular metastases in cancer of the pelvic organs. By using multiple portals of entrance, 7 to 12 fields suprapubically—3 to 6 over perineum and sacrum and 2 over each greater sciatic foramen—we may succeed in obtaining the same therapeutic results in the tissues adjacent to the posterior bony pelvic wall as with radium locally. We must tilt the tube so it will always be directed to the same area within the pelvis. The number of fields must be determined for each individual case, and depends on the diseased organ, the extent of the infiltration of surrounding structures, the region of the body and the location of the regional lymph nodes. An interval of three weeks is observed between each course. The latter is crowded into the smallest possible space of time, that is, the treatments are usually applied in one sitting. From three to four courses are given in each case.

In conclusion I wish to recapitulate:

1. The biological reaction of cancer cells to radiation offers the best evidence of the therapeutic efficiency and curative possibilities of the gamma rays and the hard roentgen rays.

2. The efficacy of the treatment must be based on the demonstrable reduction in the size of a tumor and not on the local changes and improvement in the subjective condition of the patient.

3. The evolution of a successful treatment must be guided by these observations, a correct dosage and a detailed and careful technique.

DISCUSSION OF PAPERS OF DRS. CLARK AND KEENE, SAMUEL, AND SCHMITZ

DR. LEDA J. STACY, Rochester, Minn.—Dr. Samuel, Dr. Clark and Dr. Schmitz have covered the ground so thoroughly that there is little to add in discussion. The point which Dr. Schmitz noted, as to the isolation of the cancer cells by connective tissue has been noted by us in the recurring nodules in the skin following amputation of the breast for carcinoma. These nodules may persist after repeated exposure to radium and upon excision may be found to contain cancer cells buried in connective tissue, without mitotic figures.

In the treatment of carcinoma of the uterus we have used radium only in the inoperable cases in which there was extension into the vaginal mucous membrane, or into the broad ligaments.

In a series of 79 cases of carcinoma of the uterus treated with radium, 54 have been traced and 25 per cent are living, the majority being alive for two years after treatment and all having lived more than one and one-fourth years.

In the recurrences the treatment has not been as successful, except in those cases in which only the vaginal mucous membrane was involved. But with extension into the broad ligaments the results have not been good. In a series of 24 cases of recurrences treated, 16 have been heard from and only 3 are living, but they have lived two and three years. One is a clinical cure and two have been operated on to repair a vesicovaginal and a rectovaginal fiistula, and no evidence of malignancy was found at the time of operation. In reviewing our statistics we are led to believe that the ideal treatment of operable carcinoma of the cervix uteri consists in a thorough cautery of the cervix, followed immediately by a total abdominal hysterectomy and this followed by a series of radium treatments into the vagina and deep *x*-ray treatment over the back and abdomen while the patient is convalescing from the hysterectomy. The series of radium treatments consists of 3 applications of 50 mg. of radium for twelve hours into the vagina, at intervals of four and five days. Deep *x*-ray treatment is given over the abdomen and back during this time. The patients are advised to return for a second treatment in three or four months. It will be a matter of time before the results of this postoperative routine can be determined.

The matter which Drs. Clark and Samuel brought up regarding the importance of the education of the laity to allow a complete physical examination in every case, and the careful watching of the patient, is most important. The report of the microscopic examination in a series of 158 cases treated was obtained in 64 per cent of the cases. In this series of 168 cases, 39 are living. As a rule, unless the growth is the proliferative type we do not remove a specimen for examination. I think Dr. Schmidt brought up the point of removing a portion for examination after radium treatment. We have discontinued this practice. In the few cases in which a specimen was removed for scientific study, the results were those he mentioned.

DR. J. M. LEE, Rochester, N. Y.—I feel that the Society is to be congratulated on having such a scientific and cultured gentleman as Dr. Schmitz to prepare a paper on this somewhat difficult subject.

Dr. Schmitz brings to us the results of his rich experience in histology, pathology and radiology, and we are ourselves to be congratulated on such a complete and clear discussion of the changes which develop in the cellular elements of neoplasms after the use of radium. There is nothing to do but to commend him for his work, which I am sure all of the members have done mentally already. Personally, I desire to thank him for his valuable paper, and in this I am sure I am seconded by the able men who make up the membership of this society.

His findings clearly show why it is that radium acts so efficiently in round cell sarcoma and other malignant growths which prior to the introduction of radium therapy, were rapidly fatal. It also gives us a clearer insight as to how it is that the agent is so successful in some portions of the body and not so much so in others; it also clears up the question as to how histology, pathology and age of the patient influence the effects of radium therapy. It is known to us all that cancer and sarcoma are more amenable to treatment in some sites than in others.

Dr. Schmitz's paper is so clear and comprehensive that we ought not to take issue with him; but since the profession is divided as to

the selective action of radium, Martin of Berlin leading the opposition, and Wickham and De Grais, particularly, favoring such theory, it seems only fair that as Dr. Schmitz has spoken of the effect radium produces on different layers of tissue in various dosage and screenage he should amplify the subject and give us the benefit of his broad experience.

Dr. Schmitz's technique, it seems to me, is above criticism, though his dosage sometimes is close to the border line of fatal toxicity. I have known 15,000 milligram hours radiation in about equal doses six weeks apart to cause death; and 35,000 milligram hours in equal monthly doses extending over a period of three months to prove fatal. Although larger dosage than Dr. Schmitz advises has been employed by a number of able surgeons, it seems to me that such large amounts are unnecessary and dangerous. I realize that many patients die from operations performed for the relief of cancer of the uterus, and we must not expect that the employment of efficient doses of radium in these deadly cases will always be entirely free from such results; nevertheless we should strive to prescribe the minimum efficient dose. The law which Dr. Schmitz follows is evidently the one advised by Wickham and DeGrais, viz.—the dosage should be increased inversely with the square of the distance.

Again, in radium therapy, as everywhere, we find that what one patient will bear with impunity will produce perceptible or even disastrous results on another. We formerly employed without hesitation to cover such a condition the word "idiosyncrasy." It is now looked upon as a sort of rubber cap to cover our ignorance, and for this reason the word is dropped. I know Dr. Schmitz has given in the first section of his paper the reasons for such susceptibility to the element when he says that malignancy in certain histologic elements are more resistant than others, and that certain pathologic growths, as the squamous-cell type, for instance are more difficult to treat successfully than others. This may be due to the fact that the diseased cells more nearly approach the normal. Again, he refers to the age of his patient and I presume large amounts of débris thrown down into the system might influence adversely the result.

He speaks of massive cancerous areas in the uterus and about the pelvis: this he may control by the use of radium loaded needles suitably screened and carried into the diseased tissues, and I believe his argument here is sound; but when he speaks of the use of the *x*-ray, I cannot help believing that he labors under a wrong impression. I am not in sympathy with the sentiment that seems to have grown quite prevalent all over the country, viz., that the *x*-ray is equally efficient with radium. I know this subject has received careful consideration before the convention to-day, but I did not hear it and I want to voice my sentiments of disapproval of the theory as advanced by able members of the profession in this particular. In Dr. Schmitz's use of screenage for the Coolidge tube, may I have the temerity to suggest that ¼ in of sole leather might be added to the aluminum screen to advantage. I am not an *x*-ray man and perhaps it is in bad taste for me to speak so positively on this subject; but my able assistant who handles the *x*-ray work at our hospital is unable to tell me why he has such unbounded faith in the machine; surely the results do not warrant it. Enthusiasm does not prove its superiority over radium.

Dr. C. H. Viol, Pittsburgh.—I would like to comment on the form of bomb which Dr. Schmitz has spoken of using to screen off the gamma rays. In talking with people I have usually expressed the opinion that it was impracticable to secure protection of normal tissues from the gamma rays by metallic screening, owing to the great penetrating power of these rays and the consequent mass of metal necessary for their absorption. But with the considerable thickness of lead which Dr. Schmitz has in his applicator the tissue lying back of it should be fairly well screened. One half-inch of lead will absorb one-half of the hardest gamma rays, and so the inch thickness of lead in his applicator, together with the gauze packing, should make it quite effective.

Dr. A. S. Fleming, Minneapolis, Minn.—We think that many of the undesired and irritating effects we have had from the application of radium, have been due to the secondary radiation from our metal applicators and screens. We now use gauze, rubber and distance, for screens. Applications to the cervix are made by wrapping the radium capsules in gauze and glove rubber; to the uterine cavity by placing the capsules in pure rubber gum

tubing and introducing them through the cervix.

Care is taken to push the bladder and rectum well out of the way by gauze packs, and proctitus and cystitis, of which we have heard so much, have not occurred.

I want to take exception to the statement made by Dr. Schmitz in reference to the action of radium. Ever since I have been studying radium, I have frequently met with the statement that insufficient dosage acts as a stimulant. So far as I have been able to observe, if it produces any effect at all, it is that of retardation or inhibition of cell activity rather than stimulation. I have not observed for instance that the periphery of a tumor was stimulated beyond the area where the inhibitive effects of radium could be demonstrated.

The statement of Dr. Samuel that the Percy cautery cases have not done well is also contrary to my experience. In cases of cervical carcinoma with extensive cauliflower growths in the vagina, we usually precede the application of radium by destroying all gross evidence of the disease with a Percy cautery. It has facilitated the effective application of radium, shortened and reduced the amount of toxaemia due to absorption from the retained products of the ulcerating and infected mass, and seems to aid in every way the patient's power of recuperation.

Dr. Albert Soiland, Los Angeles.—In the number of medical meetings that I have attended, it has never been my pleasure to listen to three highly scientific papers on one subject before. I think the Society should be congratulated. It was interesting to learn from Dr. Clark that the danger of perforation of the rectal wall from the treatment was not as great as we had been led to believe. I had always rather feared this in the cases where large doses had to be administered. It will help us in our work to know the danger is not so great as we had anticipated.

I was also glad to hear from Dr. Samuel that he uses the cross-fire method of treatment, combining radium and *x*-rays, and that he takes a more conservative view of the dosage, using 50 mg. as an average insertion. That is the dose which we are using in our work on the Coast.

Dr. Schmitz's talk on the histology, pathology, and therapeutics of these cases was illuminating and very instructive. I would like to ask whether in the use of his "bomb," it is difficult to keep this in place, and whether it is uncomfortable to the patient. If he will permit me to do so, I shall adopt this device in cervical cases.

Dr. H. Janeway, New York.—I wish to add my experience in the treatment of uterine cancer. My technic has been to apply three tubes in the utero-cervical angle, and in this way give three thousand mg. hours, in addition to applying a separate dose to the cervix. Formerly we used a smaller dose but now we use one of three thousand mg. hours. I have not used filtration for the vagina and have not thus far encountered any proctitis or vesical irritation. In fact, the patients have complained of very few symptoms following the treatment. I usually give only one treatment. These questions can only be settled by comparing end results, and that cannot be done right away. My oldest case goes back three and one-half years.

Dr. T. C. Kennedy, Indianapolis.—I am glad to hear some of the essayists say that they use 50 mgs. as a routine treatment in the conditions under discussion. I began the treatment of these cases with 50 mgs. but thought perhaps more could be accomplished with large doses, and tried using from 100 to 150 mgs., but am convinced that this is too much, and now as a routine practice I use 50 mgs. I am sure I get better results with the 50 mg. applicator than I did with the larger amounts.

My experience with cystitis and proctitis following the application of radium is different from what Dr. Janeway relates. Some cases have given great annoyance for several weeks. In proctitis from radium I have used injections of olive oil as recommended by Rausohoff, and have been able to relieve my patients.

The early diagnosis of cancer is very important, but frequently the patient is beyond relief before she is aware that she has the disease.

Until patients know there is something the matter with them it is very difficult to get them to go to a physician for examination.

Dr. C. E. Alliaume, Utica, N. Y.—I have used a screen similar to Dr. Schmitz's lead bomb quite extensively, but have recently discarded it because it was very uncomfortable for patients and made them dread future treatment. In vaginal treatments, I use hard rubber

plaques as screen to protect the bladder and rectum. I enclose the radium in rubber tubing which is just a little longer than the radium tube, and put it into a finger cot, the end of which is tied with a thread. A long linen thread extends from the ring in the radium screen out of the vagina, and is attached to the thigh with adhesive plaster. The radium package and protecting screens are held in place by a one-piece gauze packing. In intra-uterine radiation, I place the radium in the end of a long rubber tube of small calibre, the end of which is tied with a thread. Into this rubber tube I place a long heavy copper wire, the end being bent into a very small circle. This end is placed alongside of the radium inside of the rubber tubing and a thread is tied about the outside of the rubber tube just behind the radium, holding the wire and tubes of radium in place. This wire is of sufficient length to protrude from the vagina and to be bent up over the groin and fixed in place there with adhesive plaster. A gauze packing is introduced into the vagina about the tube as it emerges from the cervix, being packed rather firmly before the vaginal speculum is removed. A vaginal pad and "T" binder are then applied to hold it all securely in place. The only cases of proctitis which have resulted from radium treatment in my experience, have been in cases where treatments were given in or through the rectum either for rectal, vaginal or uterine lesions.

Regarding Dr. Fleming's experience with the Percy cautery, it seems incredible that many cases of uterine cancer which have developed very far could be treated without establishing the fact that in treating such cases with the Percy cautery profound sepsis is frequently produced. The Percy cautery treatment has many objectionable features, while radium has none and offers far better results than any other known treatment.

Dr. John G. Clark, Philadelphia.—As to the question of treating patients suffering with recurrence after hysterectomy I am in hearty accord with Dr. Stacey. I dread to see them come to my clinic. They resort to radium as a desperate chance, but I am sorry to say that seldom do these cases obtain even temporary relief or palliation.

With the uterus as a wedge or block between the rectum and bladder the dangers of destructive action to either of these organs is greatly lessened. When however, they lie in close contact, as they do after hysterectomy, it is more hazardous to apply radium. If the recurrence has produced a crater without an intervening barrier of vaginal tissue I now refuse to treat these cases. We can not even mitigate the symptoms and we stand big chances of producing recto- or vesico-vaginal fistulae.

As to the point in our discussion relative to the repetition of treatments, I hold that if after two applications of radium we observe no benefit the treatments should cease during this time, for in our experience it either improves the condition at once or fails. In discussing this question a few days ago before the Annual Session of the New York State Medical Society the question was asked by Dr. Cullen of Balitmore as to whether we had noted any difference in the action of radium in cases of the epithelial and adenomatous type of carcinema of the cervix. In his experience he had found that the adenomatous type was practically incurable so far as surgery is concerned. This point in the future should be kept in mind by all of us in our classification of cases. At first we curetted these cases to obtain diagnostic material; we do so no longer, for 99 per cent of the cases that apply to us for treatment are inoperable and therefore the diagnosis is self evident. Therefore, we traumatize these cases as little as possible believing that we thus serve the best therapeutic end by a "touch me not policy." Under this thought I particularly am in accord with Dr. Alliaume who deprecates the preliminary use of a curette or the Percy cautery. By all means leave the cautery out of consideration, or you will charge against the radium account fistulae caused by the cautery. So far as the dangers of a toxaemia or sepsis being caused by radiation, they are theoretical rather than real. I have seen large cauliflower masses melt down under radiation without the slightest coincident toxic symptom.

The question of technique of application should be referred to the Research Committee of this society for standardization. As soon as possible we should lay down definite rules for dosage, repetition of treatments, care of the patient, follow-up system, etc. Only by such standardization may we reach a common ground for discussion and observation. We have two schools of radium therapy, one having unlimited amounts of radium, the others in comparison having infinitesimal amounts. In considering results, therefore, they should be comparative between those who have

massive and those who have minimum amounts of radium.

As to the use of various screens used to protect the rectum and bladder in vaginal applications, I have discarded them all in favor of simple gauze packing, and it is quite as effective as lead shields, twenty dollar gold pieces, etc.

DR. HENRY SCHMITZ, Chicago.—I have followed the discussion with a great deal of interest and wish to thank all, especially Dr. Lee for his very fair criticism of the papers. When I mentioned the efficacy of the *x*-ray as an adjunct to radium treatment of deep seated malignancy, I spoke from actual observation; the *x*-ray will influence the growth. Creditable results can be obtained by the use of a proper technique of the roentgen therapy.

Dr. Fleming spoke about the stimulation of the cells by radium rays. There is no doubt that a certain number of cells on the periphery of the growth will undergo proliferation if the intensity of the rays is insufficient. These peripheral cells are stimulated to an increased proliferation by too small an amount of radium or too short an exposure. Experimentation proves this point. Plants may grow to a much greater size than normally by applying a small amount of radium, and vice-versa, their development may be dwarfed or crippled by an amount of radium that will injure the growing plant cells. This fact has also been biologically illustrated in animal experimentation. Therefore the same facts apply to the human body, and if we administer a dose of rays that is not sufficient to cause degeneration, we stimulate proliferation and therefore cause a rapid growth.

The reason I employ the bomb is to protect healthy tissue from the action of the rays. I have three cases under my care who have a stricture of the rectum resulting from radium treatment in the vagina. The stricture occurred at a point where there was healthy tissue. The only way I can explain this occurrence is that the recto-vaginal septum is very thin and the penetrating rays injured the healthy rectal tissue. In one instance we had to do a resection of the rectum, which relieved the patient of the severe distress. In several other cases of cervical cancers which had healed locally, we saw a stricture of the rectal wall. The patients are not incapacitated, but I have no doubt that they will be after a while on account of the progressive nature of this injury. The size and weight of the bomb has never inconvenienced the patient. The packing, which of necessity must be quite firm, gives a feeling of fullness to the patient but never a sense of weight.

In conclusion, I wish to agree with Dr. Clark, whose paper was a revelation not only to me but to all of us, that we should find some means by which this society can standardize the use of radium, that is, establish the lethal dosage, determine the best method of application, evolve practical instruments and enable us to compare the clinical findings.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $6.00 per year Advertising rates submitted on application. Editorial office, 480 Park Av., New York. Office of publication, 67-69 East 59th St., New York.

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TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15, 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

THE HEART SYMPOSIUM

One of the more inspiring sessions of the Saratoga meeting was that devoted to the heart symposium. It was a timely invasion of a field prolific in opportunity but much neglected by the American roentgenologist. Perhaps one reason for this neglect has been the apparent self-sufficiency in cardiac diagnosis on the part of the internist. But a far more potent reason is that the roentgenologist himself has utterly failed to appreciate the wonderful fertility of this field of endeavor.

Van Zwaluwenburg has done well to emphasize the fact that roentgen-cardiac diagnosis is much more than a mathematical problem. Those eminent medical authorities who teach that a heart is abnormal when, and only when, its borders project across certain arbitrarily drawn lines, refuse to acknowledge the fact that the normal heart presents as many variations in size, both actual and relative, as does the stomach. Thus a thirteen centimeter heart might still be markedly dilated if its normal width was nine centimeters, while one fifteen or more centimeters in width might well be normal for another individual. Even less promising are the attempts to establish a standard ratio of cardiac and chest dimensions, for a broad chested individual is not infrequently endowed through heredity with a small heart, while another may receive through one parent an ample cardio-vascular system, housed within a restricted chest cavity inherited from the other parent.

There is surely much to be gained by a more careful study of muscular action as manifested by pulsation phenomena. Thus the apparent shortening and rotation of the "drop" heart in systole is quite characteristic, while in mitral insufficiency the vigorous, somewhat irritable contractions of the left ventricle, accompaniel by the distension of the auricle and pulmonary artery, are sometimes readily detected upon the fluoroscopic screen. And as the art becomes

perfected, may we not hope to see and count auricular pulsations as accurately as we now do those of the ventricle? When we are able to demonstrate two pulsations of the auricle with each ventricular beat, we shall have easy access to a diagnosis of heart block. A series of arhythmias studied by both electro-cardiograph and fluoroscope might throw new light upon them. The positive systolic pulsation of the jugular vein is a well established clinical sign of tricuspid insufficiency; but not so well-known is the positive venous pulsation within the lung hilum in mitral insufficiency. For the latter, of course, is a sign which may be observed only upon the screen.

The excellent research work of Holmes has defined certain limitations beyond which the roentgenologist cannot hope to go in the diagnosis of pericardial effusion. The physical law of relative density may not be changed to suit our purposes. And he who would see the heart shadow suspended in pericardial effusion is usually up against this immutable law. But when denied such obvious and absolute signs as this, we are compelled to fall back upon our more indirect manifestations of this process, which offer a fairly satisfactory degree of diagnostic accuracy.

It is to be hoped that more consideration will be given by roentgenologists to the study of cardiac mobility, which when abnormal, is becoming recognized as a cause of circulatory weakness.

BISSELL

BOOK REVIEWS

LOS RAYOS X EN EL DIAGNOSTICO DE LAS ENFERMEDADES DEL ESTOMAGO. By Doctors José Gonzalez Campo and José Gonzalez-Campo de Cos, Specialists in diseases of the digestive tract, Madrid, Spain. 260 pages, 17 illustrations and 28 roentgenograms. Published by Imprenta Blass y Cia., San Mateo, 1, Madrid, 1919.

This is an excellent clinical treatise on the roentgenology of the digestive tract written from the standpoint of the clinical radiologist. Dr. Campo was the first gastroenterologist in Madrid to install an *x*-ray equipment. The authors utilize this means on a par with other clinical and biological methods of investigation; and an effort has been made, so the authors state in their introduction, to regard roentgenology as a laboratory aid and to utilize all other diagnostic means at the same time. They insist that they are not roentgenologists, because they have practiced roentgenology in connection with their specialty for a number of years, any more than they could be considered chemists because in their offices they analyze the gastric and other digestive juices. Nevertheless, in a large practice covering several thousand cases explored with the roentgen rays, the authors have accumulated a considerable experience in the roentgenology of the digestive tract. They therefore feel qualified to write this book in order to place before Spanish readers the summing up of the present day knowledge of this diagnostic means in diseases of the alimentary tract. They have evidently familiarized themselves with the most important literature on the subject, and free reference has been made to the standard works of American and European roentgenologists. The book is charmingly written and can be heartily recommended to the Spanish medical profession.

JAMES T. CASE.

TRANSLATIONS & ABSTRACTS

SIMMONS, CHANNING C. The Treatment of Carcinoma of the Skin with Radium. The Results of the Cases Treated at the Collis P. Huntington Memorial Hospital. (*Boston M. & S. J.*, Vol. XXXI, No. 16, October 16, 1919.)

The policy has been not to use radium in all cases of malignant disease applying for treatment but to advise operation if it seems best in a given case. In certain of the milder cases in which the growth is favorably situated, operation gives a better immediate result and a greater hope of permanent cure. In another class of advanced cases operation, to remove the greater portion of the growth, followed by radium treatment, is the treatment of choice. Most of the cases are suitable for radium treatment and can be divided roughly into two classes—those in which a permanent cure is to be expected and those in which the disease is extensive and in which radium is used as a palliative measure to retard the rate of growth.

Radium is particularly valuable in the treatment of skin cancer arising about the orbit. Less deformity of the lids results by the destruction of the growth in this manner than by operation, which can always be performed later if the radium treatment is unsuccessful.

On the other hand, in some cases, especially where the growth is situated about the ear or on the cheek, operation, followed by a plastic flap or skin graft, gives a better result.

A plastic operation for ectropion or deformity of the nose after the destruction of the growth by radium, but should not be attempted until all inflammatory reaction from the radium has subsided and sufficient time has elapsed to make the possibility of recurrence remote. Carcinoma arising on the tip of the ear responds very slowly to radium and operation is usually the treatment of choice, the resulting deformity being less noticeable than would be expected.

All patients should be warned of the possible depilatory effects of the radium, as the beard, eyebrows, or eyelashes may be unavoidably destroyed. Treatment inside the buccal cavity even will frequently destroy the beard. In treating carcinoma in the region of orbit, they should also be warned of the probability of conjunctivitis. A Wassermann test should be taken in all cases in which there is the slightest suspicion of syphilis, as the clinical diagnosis differentiating between rodent ulcer and syphilis is at times difficult. It must not be forgotten, however, that carcinoma can arise in a syphilitic ulcer, or that the two conditions may be coexistent and have no relation to each other.

It has been made a rule not to treat carcinoma of the lip with radium except in cases where operation is contraindicated on account of diabetes, high blood pressure, or the extent of the growth, as we consider operation the only proper treatment. We have seen cases in which a small carcinoma of the lip had been entirely destroyed by radium develop hopeless carcinoma in the glands of the neck a few months later. Keratosis of the lip, the precancerous condition, yields readily to radium, which is the treatment of choice.

Methods of Treatment.—The actual method of applying the radium for treatment varied greatly as to the type, situation, and extent of the growth. The usual procedure in the small superficial tumors in accessible regions was to fasten the glass tube containing the emanation, which was in turn enclosed in a steel needle, to the top of a metal cone 1 cm. in height, the diameter of which was slightly larger than the growth. The cone has a broad flange on the bottom which protects the surrounding skin from the action of the rays. The cone with the radium attached was then fastened over the growth and allowed to remain in place for from one-half to two hours. The usual dose was from 20 to 50 millicuries, although heavier treatments have recently been used. In growths about the scalp or orbit, sheet lead was also used as a protection to prevent loss of hair or conjunctivitis, which, in spite of all precautions, often follows the treatment of carcinoma of the lids. The average small growth usually disappeared in from two to four treatments, often in one, but the resulting superficial ulcer heals slowly. After the first treatment, patients report once in two weeks for observation and further treatment, as necessary. We have found that the best method of treating the superficial ulcers is to instruct the patient to bathe them once or twice daily with a solution of peroxide and water, equal parts, and keep them covered with white vase-

line or other bland ointment, on a piece of compress cloth.

In the large superficial growths the steel needles containing the radium emanations were usually laid directly on the growth in a series around it a short distance inside the edge. The bare glass tubes are also, at times, used in a similar manner, or raised up ½ cm. from the surface on a piece of gauze.

Fungoid growths, where there was considerable tumor tissue, were often treated by imbedding the glass tube containing the emanation directly in the tumor and leaving it *in situ*. One or more tubes containing from 5 to 12 millicuries were usually embedded in this manner.

In large growths on the cheek which have involved the bone and infiltrated the antrum much may be accomplished by removing the tumor by operation with the knife, curette, and actual cautery. A tube of radium may be introduced into the cavity thus formed in the gauze packing at the time of operation and left in place for from twelve to forty-eight hours, depending on the amount used. The deformity following these operations on the upper jaw is surprisingly little, considering their extent. Further radium treatments are given as indicated. The same procedure may be followed after eventration of the orbit for cancer, or, if there is a chance of all the growth having been removed, the radium treatment may be delayed until a recurrence appears.

All cases are requested to report at the hospital regularly for observation whether they need treatment or not. Cases which do not report are followed up at the end of six to twelve months from their last visit to determine their condition.

The 259 cases, for convenience of study, were divided into the following groups: Cancer of eyelids and about the orbit, 52 cases; cancer of the nose, 79 cases; cancer of the cheek, 71 cases; cancer of the forehead, 27 cases; cancer about the ear, 24 cases; miscellaneous cancer (hands, feet, etc.), 6 cases.

Of these cases 201 (77 per cent) had previously received some form of treatment. In some the growth had been destroyed but had recurred, while in others treatment had had little or no effect. Many patients had drifted from one physician to another and had tried several different remedies. Many of the methods of treatment employed are well recognized and it must be borne in mind that we only saw the unsuccessful cases and have no means of judging the numbers cured. A list of the more common methods employed is given below:

X-ray	61	cases
Violet light	4	"
Finsen light	1	"
Radium	11	"
Electricity	3	"
Operation	67	"
Cautery	13	"
Freezing (liquid air, etc.)	6	"
Cancer pastes	27	"
Ointments	44	"
Treated by many remedies	49	"
No previous treatment	56	"
No data	2	"

END-RESULTS

No recurrence 1 year	8	cases	
No recurrence 2 years	14	"	
No recurrence 3 years	51	"	
No recurrence 4 years	22	"	
Recurrent cases	26	"	21.4%
Result unknown	3	"	

(Of the 26 recurrent cases, 13 yielded readily to further light treatment.)

SLESINGER, *E. G.* Osteitis Fibrosa. *(The Lancet,* CXCVII, 5020. November 15, 1919.)

The condition known as osteitis fibrosa is now recognized to be a good deal commoner than was at one time supposed; but even at present some obscurity attaches to it, partly on account of the very mixed nomenclature under which it has been described in conjunction with several other entirely different diseases occurring in bone. A further difficulty arises from the fact that opinion appears to be still divided as to whether osteitis fibrosa, as it occurs in a single bone, and von Recklinghausen's multiple fibro-cystic disease of the bones, are or are not the identical disease. The study of these two diseases however, leads one to the belief that the conditions are unconnected, except in so far as in both there occurs a localized or generalized replacement of the bone marrow by a fibroid tissue. Further, von Recklinghausen's disease occurs as a rule fairly late in life, while osteitis fibrosa is essentially a lesion of the epiphyseal period.

Etiology—Opinion is fairly evenly divided between the views that (1) it represents a metaplastic transformation of the bone marrow into a fibroid tissue, and (2) that it is the result of a chronic inflammation of unknown origin occurring in the endosteum.

Bone Affected—Three of the long bones seem particularly liable to this condition,

namely, the femur, the humerus, and the tibia. Almost without exception all the cases in which the solid form of the disease has been observed have occurred in the femur. After the three bones mentioned above, the next most liable are the fibula and the phalanges. It does occasionally occur in other bones, but only very rarely.

Symptoms—The symptoms of this disease are essentially those of its complications and of the deformities that result from it, and the disease may be, and often is, present for a considerable time without sufficiently bothering the patient to force him to seek advice. Pain is very often absent until the onset of some complication, such as fracture; but some patients complain of aching in the bone, particularly at night.

The most helpful evidence from a diagnostic point of view is often given by the *x*-ray appearances. Expansion and thinning of the bone are most marked in those cases with cyst formation and the appearance of a clear space in the bone, crossed by a number of trabeculae, forms the usual pictures. The trabeculae, however, are no guide to the extent of actual cyst formation and may be as marked in the solid cases as in those in which a number of cavities are present. A further point noted in the *x*-ray plates is the tendency of the clear area to be prolonged down the shaft in a pointed extension in contrast to the usually rounded lower limit of a myeloma. The differential *x*-ray diagnosis between osteitis fibrosa, myeloma, other cyst-forming conditions, and some cases of tuberculous disease, is often difficult or even impossible.

Diagnosis—The diagnosis of osteitis fibrosa rests on its differentation from other conditions causing expansion of the bone during the epiphyseal period. Difficulty sometimes occurs in regard to tuberculosis, but in this condition the limitation of motion which occurs is in all directions, whereas in osteitis fibrosa it is merely that of the resultant deformity, and further in the latter condition it is rare to find pain. From myeloma or enosteal sarcoma the differential diagnosis is often extremely difficult, and here the *x*-ray examination is often of extreme value.

In many cases, however, the diagnosis can only be made at operation or even only after microscopical examination of the tissue removed. Even here difficulties sometimes occur, and cases are seen in which the cellular character of the tissue makes it difficult to be certain of the innocent character of the section. Indeed almost all stages, from a typical osteitis fibrosa to an equally typical fibrosarcoma, can be met with, and in doubtful cases only a guarded opinion from the pathologist point of view can be given. W. W. BELDEN.